RESEARCH & DEVELOPMENT IN INDUSTRY

1988-89

GOVERNMENT OF INDIA
DEPARTMENT OF SCIENCE & TECHNOLOGY
New Delhi

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FOREWORD

The Indian industry has made considerable progress in manufacturing a wide variety of products, intermediates, consumer goods and capital goods. A fairly large industrial base has been created through substantial investments in this sector. Simultaneously, through our infrastructure for education, training and research, a large number of highly qualified scientific and technical personnel and other skilled technicians with considerable investigative, innovative and inventive capabilities has become available for meeting our research, production, maintenance and quality control needs.

Research and Development (R&D) are essential facets of any industrial activity, especially in the wake of growing competition, and for promoting efficiency, profitability, industrial competitiveness and technological self reliance. It is recognised that R&D efforts needed for industrial production are best undertaken in, and by, industry itself. The increasing attention being paid by industry to activities in this area can be gauged to some extent from the growth in the deployment of both manpower and financial resources for R&D as brought out by the time series analyses.

The data and analyses of the extent of research and development activity of industries and its growth presented here, would not only meet the demands of the planners and policy makers but also the needs of a large number of scientists, technologists and industrialists. The Department of Science and Technology, therefore, makes special efforts to collect, compile and analyse data on resources devoted to research and development activities by the industrial sector and presents them in a separate report. This report for the year 1988-89 contains substantial information on the deployment of manpower and financial resources on R&D activities by the industrial sector in the country.

The Department of Science and Technology would welcome comments on this publication, and suggestions for possible incorporation in the future editions in respect of its content and presentation. We would like to place on record our sincere thanks to the industrial and other institutions for providing us the data to make this report possible. The Department looks forward to their continued cooperation in this regard in the future as well.

This report has been prepared by Shri Rakesh Chetal under the guidance of Dr. Smt. A.R.Rajeswari. Shri Chetal had also developed software in-house for processing of the data. The data entry and other support services had been rendered by their other colleagues.

(Vasant Gowariker)
Secretary to the Government of India
Department of Science and Technology

New Delhi,
October 20,1990.

HIGHLIGHTS

- The number of industries having in-house R&D activities during 1988-89 was 1016. Out of this, 895 were in the private sector.
- The total R&D expenditure by industrial sector at current prices attained the level of Rs.725.11 crores during the year 1988-89 which was 20.9% of the total national expenditure on R&D activities. This worked out to be 0.21% of gross national product.
- The industrial units spent about 0.72% of their sales turnover on research and development activities in 1988-89.
- About one fourth of total industrial sector R&D units which belonged to Defence, Electricals & Electronics and Metallurgical industries accounted for about one half of total industrial sector R&D expenditure.
- About one half (49.2%) of the total industrial sector R&D expenditure was spent on the objective promotion of industrial development during 1988-89.
- Total full time equivalent of personnel employed in 949 industrial sector R&D units for which data were available was estimated at 62926. Out of this 31145 were engaged in R&D activities which works out to be about 32% of total R&D personnel employed at national level.
- A little more than one fourth of total industrial sector personnel primarily engaged on R&D activities were having post graduate or above qualifications.
- Investment on research and development activities by private sector was of the order of Rs.363.78 crores in 1988-89 which was 17.2% more than the R&D expenditure of previous year.
- The private sector R&D expenditure constitutes 10.5% of total investment in R&D at national level and it was 0.11% of Gross National Product.
- The private sector spent about 0.62% of their sales turnover on research and development activities during 1988-89.
- The industry groups Electricals and Electronics, Chemicals, Drugs and Pharmaceuticals, Industrial Machinery, Transportation and Metallurgical industries accounted for 69.9% of total R&D expenditure during 1988-89.
- About 72.6% of total R&D units of the private sector were located in the States of Maharashtra, West Bengal, Tamil Nadu, Gujarat, Karnataka and Bihar accounting for about 80.4% of total R&D expenditure in 1988-89 in that sector.
- About 5.9% of total private sector R&D expenditure was accounted by 215 industries in the small scale sector during 1988-89.
- As on 1st April, 1988 about 35315 personnel were employed in private sector industries. Out of this, 18493 were engaged on R&D activities.
- For every 1000 R&D employees in private sector 51 were female R&D employees.
- About 60.2% of total R&D personnel engaged directly on R&D activities had engineering as their field of specialisation.
- About 70.8% of total R&D personnel engaged directly on R&D had

graduate or lower qualifications in natural sciences,agricultural sciences, engineering and technology, medical sciences and social sciences.

* Investment by public sector in-house R&D units on research and development activities for the year 1988-89 attained a level of Rs.361.32 crores at current prices which was 10.4% of total investment on R&D at national level.

* Public sector spent on an average 0.77% of their sales turnover on research and development activities during 1988-89.

* A little less than 25% of total public sector R&D units under Defence and Electricals and Electronics industry group have spent more than one half (53.1%) of total public sector R&D expenditure.

* About 89.7% of total public sector R&D expenditure was shared by public sector industries under eight ministries/departments viz.,Defence Production and Supplies, Public Enterprises, Steel, Petroleum and Natural Gas, Telecommunications, Coal, Petrochemicals and Fertilizers during the year 1988-89.

* 48.8% of public sector industries located in the States of Karnataka, Andhra Pradesh, Bihar, Haryana, Gujarat and Maharashtra accounted for about 87.5% of total public sector R&D expenditure during 1988-89.

* As on 1st April,1988 about 27611 personnel were employed in public sector R&D units. Out of this 45.8% were directly engaged on R&D activities.

* Out of every thousand R&D employees in public sector 47 were female R&D employees.

* 82.7% of the total R&D personnel in public sector had engineering as their field of specialisation.

* More than three fourth (78%) of total public sector R&D personnel had graduate or lower qualifications. Only 5.4% of total public sector R&D personnel had Ph.D qualifications.

R & D
IN
INDUSTRIAL SECTOR

CHAPTER-I
R&D IN INDUSTRIAL SECTOR

The Science and Technology has contributed a lot in improving the quality of life in all parts of the world and there are great expectations from Scientific and technological development within the country. The Government of India has attached considerable importance to science and technology and has created an impressive infrastructure over the years. This includes national laboratories, R&D institutions, academic institutions and industrial R&D units. This chapter contains information and analyses on the financial and human resources devoted to industrial R&D activities which represent the principal input to R&D and can be used as indicators of commitment of industry to innovation.

It is a well known fact that research and development in industries is essential for generating know-how necessary for production of quality goods, promoting efficiency, promote exports and technological self reliance needed in the country as well as for meaningful assimilation and further development of imported know-how. Research and Development in industrial sector is essential for solving day to day production problems and for exploring the potential for future industrial expansion.

Industrial sector in India comprises of industries in the public sector/joint sector under central and state governments and industries in the private sector. A scheme for granting recognition to in-house R&D units in the industrial sector and private and public funded research and development laboratories was being operated by Department of Science and Technology from 1973. This scheme is now being dealt by Department of Scientific and Industrial Research. One of the objectives of this scheme is to provide liberal import facilities to recognised R&D units. These units can import under open general licence (OGL) equipment, components and raw materials etc. required for research and development work leading to updation of technology, effecting improvements in the manufacturing process, introduction of new products/processes and developing substitutes for imported items. The in-house R&D units qualified for recognition are expected to be engaged in research and development activities related to the manufacturing activities of the company. The incentives mentioned above have encouraged to a large extent industries to establish their in-house R&D centres.

As on 1st September, 1988, about 1016 R&D units were recognised by the Department of Scientific and Industrial Research and these units were contacted by mail card enquiry for the survey. Out of this, 895 in-house R&D units were in the private sector and the rest 121 in public/joint sector. Requisite information in the questionnaire specially designed for this survey has been received from 828 private sector R&D units, 121 public/joint sector R&D units and the R&D expenditure for the rest 67 in-house R&D units of private sector have been projected to arrive at the total private sector R&D expenditure. However, the detailed analyses of data in respect of R&D expenditure by industry group, by fields of science, by objectives and by R&D manpower are based on the actual data received from 828 private sector and 121 public/joint sector respondents.

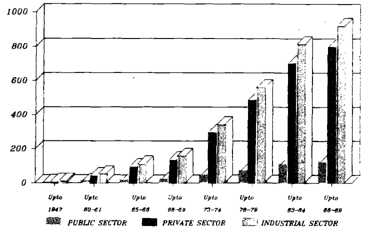
Out of 1016 industrial sector R&D units who have responded to the questionnaire, 920 have sent information on the year of setting up of R&D facilities.This information have been classified into different periods and may be seen from Table 1.1.

Table 1.1
SETTING UP OF R&D UNITS BY THE INDUSTRIAL SECTOR

	Period	Number set up
1.	Pre-Independence	11
2.	August, 1947 to 1960-61	43
3.	Third Five Year Plan(1961-62 to 1965-66)	59
4.	Annual Plans(1966-67 to 1968-69)	45
5.	Fourth Five Year Plan(1969-70 to 1973-74)	185
6.	Fifth Five Year Plan(1974-75 to 1978-79)	216
7.	(1979-80 to 1983-84)	254
8.	(1984-85 to 1988-89)	107
	Total	920

It is quite evident from Table 1.1 that research and development by industries is a recent phenomenon. Before the country became independent there were only 11 industrial units which had facilities for the research and development. During the 3rd Five Year Plan, about 59 units were understood to have set up R&D centres. It would be pertinent to mention herein, that this almost synchronised with the enactment of income tax act, 1961 which provided liberal tax incentives for R&D. During the fourth five year plan, the number of such units rose to 185. In 1973, the Government of India started a scheme of registration of R&D establishments with Department of Science and Technology which is presently being handled by Department of Scientific and Industrial Research, in order to encourage industrial establishments to set up R&D facilities. The impact of this scheme could be observed during the fifth five year plan period, when 216 R&D units were reported to have set up R&D facilities. The peak was observed during the years 1979-80 to 1983-84 when about 254 R&D units were reported to have added R&D facilities.

CUMULATIVE GROWTH OF R&D UNITS IN PRIVATE, PUBLIC AND INDUSTRIAL SECTOR



In this context the graph may also be seen which indicates the cumulative growth of industrial R&D units in Public, Private and Industrial sector.

As a natural consequence of increase in the number of in-house industrial R&D units, their investment on R&D has also been steadily increasing as may be seen from the graph. It may be mentioned here that no authentic information was available regarding the investment on R&D by industrial sector right upto 1957-58 and also no separate information was available for public sector industries till 1971-72. In the next few paragraphs, discussion on the data and analyses of R&D expenditure by industry over the decade 1980-1990 has been attempted.

The total investment on R&D by the industrial sector has increased from Rs.207.06 crores in 1980-81 to Rs.450.56 crores in 1985-86 to Rs.527.33 crores in 1986-87 to Rs.598.73 crores in 1987-88 and to Rs.725.11 crores in 1988-89. It is worthwhile to mention here that the growth in the R&D expenditure of industrial sector was mainly because of (a) increased awareness of the importance of the R&D activities (b) increase in the number of R&D units. The number of in-house R&D units for public and private sector during 1988-89 were 121 and 895 respectively. Based on the growth rates observed so far, the R&D expenditure projected for the year 1989-90 was Rs.852.06 crores.

The R&D expenditure for 1988-89 was about 20.9% of the total national expenditure on R&D activities. In terms of absolute value, the total R&D expenditure at current prices was Rs.725.11 crores. The total industrial sector R&D expenditure worked out to be 0.21% of the Gross National Product at current prices during 1988-89. The growth of expenditure of 1988-89 over the previous year at current prices was about 21.1% and at constant prices based on 1980-81 prices the growth in expenditure for the same period worked out to be about 12.8%.

R&D expenditure at constant prices with 1980-81 as the base year, for the period 1982-83 to 1988-89 may be seen in Table 1.2.

GROWTH OF INDUSTRIAL SECTOR R&D EXPENDITURE

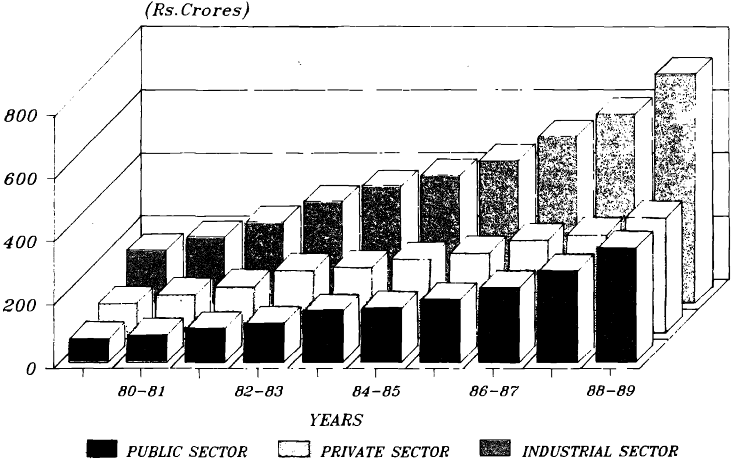


Table 1.2
GROWTH OF R&D EXPENDITURE AT CONSTANT PRICES

Year	R&D expenditure (in Rs.crores) at constant prices (Base 1980-81 = 100)	% Annual growth rate over the previous year
1982-83	268.23	-
1983-84	286.14	6.7
1984-85	291.47	1.9
1985-86	302.30	3.7
1986-87	330.68	9.4
1987-88	345.50	4.5
1988-89	389.78	12.8

The R&D expenditure at constant prices was worked out by using GNP deflators.

Table 1.3 gives the R&D expenditure and the number of R&D units for public sector, private sector and industrial sector as a whole for latest three years.

Table 1.3
R&D EXPENDITURE BY PUBLIC, PRIVATE AND INDUSTRIAL SECTOR FROM 1986-87 TO 1988-89

Sector	No. of Units	R&D Expenditure 1986-87	1987-88	(Rs.crores) 1988-89
Public Sector	121	235.70	288.47	361.32
Private Sector	895	291.63	310.27	363.79
Industrial Sector	1016	527.33	598.74	725.11

It may be interesting to note from Table 1.3 that 55% of the total industrial sector investment on R&D was incurred by 895 or 88% of private sector in-house R&D units whereas 45% were incurred by 121 or 12% of public sector R&D units during 1986-87. The share of private sector has decreased to 50.2% and the share of public sector has increased to 49.8% in 1988-89 with the share of number of private and public sector R&D units remaining the same as in 1986-87. It may be interesting to note that though the number of R&D units for Public and private sectors were kept constant for the duration of three years, the share of public sector R&D expenditure has been growing in the total industrial sector R&D expenditure. This indicates that pace of spending on R&D activities by public sector was higher than private sector during the three years period under study. It may be noted from Table 1.3 that per unit R&D expenditure for private and public sector were Rs.0.41 crores and Rs.2.99 crores respectively during 1988-89. The difference between two sets of figures was very significant and may be attributed to the big size of companies in public sector and further their need for complex and sophisticated technology calling for higher investment on R&D whereas private sector R&D units are heterogeneous in size which even include small scale industries spending very little on R&D.

It is well known fact that industries are profit oriented and the investment on R&D by industries is to a large extent conditioned by the financial benefits accruing to them by way of increase in production, sales and reductions in the cost of production etc. The investment on advertisement also aims at increase in sales. Therefore, the information regarding R&D expenditure as percentage of sales turnover, advertising expenditure as percentage of sales turnover and purchase of new plant and machinery and its percentage share in the sales turnover were compiled to assess the relative importance given by the industries to R&D, advertising and purchase of new plant and equipment. The R&D expenditure as percentage of sales turnover for industrial sector works out to be 0.72% for the year 1988-89. It may not be out of place to mention that this figure for a number of advanced countries of the world ranges between 3% to 4%. The investment on advertising and on new plant and machinery as percentage of sales turnover for industrial sector was 0.31% and 2.91% respectively during the year 1988-89. It appears from this that industry have higher priority for expenditure on R&D as compared to advertising, but less priority than the purchase of new plant and machinery.

The total industrial sector investment on R&D has been apportioned into 38 industrial groups on the basis of the products manufactured by them. Out of the 38 industrial groups identified, 11 leading industry groups arranged in descending order of their expenditure spent about 85% of total industrial sector R&D expenditure in 1988-89. Table 1.4 gives information on the number of R&D units, R&D expenditure in each group by leading groups for 1986-87 and 1988-89 and the average annual growth in R&D expenditure of 1988-89 over 1986-87.

Table 1.4
INDUSTRIAL SECTOR R&D EXPENDITURE BY LEADING INDUSTRY GROUPS FOR 1986-87 & 1988-89

Sl. No.	Industry Groups	No.of Units	R&D Exp.(Rs.lakhs)		Annual compound rate of Growth
			1986-87	1988-89	
1.	Defence Industries	8	6103.62	12970.30	45.7
2.	Electricals & Electronics	167	9485.82	11802.51	11.5
3.	Metallurgical Industries	80	4581.59	7493.09	27.9
4.	Chemicals (Other than Fertilizers)	162	4738.78	6664.60	18.6
5.	Drugs & Pharmaceuticals	84	4636.82	5600.45	9.9
6.	Telecommunication	44	3837.05	4265.47	5.4
7.	Industrial Machinery	86	2336.89	2966.04	12.6
8.	Transportation	39	2032.89	2773.59	16.8
9.	Fuels	13	1773.33	2041.76	7.3
10.	Textiles	29	1274.47	1375.84	3.9
11.	Fertilizers	8	1004.17	1365.77	16.7
12.	Other Groups	229	8744.57	10467.41	9.4
	Total	949	50550.00	69786.83	17.5

It may be noted from Table 1.4 that 18.6% of the total industrial sector investment on R&D during 1988-89 was shared by 8 R&D units in Defence group, 16.9% by 167 R&D units in Electricals and Electronics group, 10.7% by 80 R&D units in the group of Metallurgical industries, 9.5% by 162 R&D units in the group of Chemicals (other than fertilisers), and 8.0% by 84 R&D units in Drugs and Pharmaceuticals group. These five groups account for 63.7% of the total industrial sector R&D expenditure. It appears from this that R&D expenditure was concentrated in few industry groups. It may not be out of place to mention that while interpreting this the number of R&D units in each industry group have to be kept in mind. It may also be seen from Table 1.4 that the annual compound rate of growth of R&D expenditure from 1986-87 to 1988-89 for three major industrial groups of Defence, Metallurgical Industries and Chemicals (other than fertilizers), in that order was more than the overall growth rate for the industrial sector, as a whole which worked out to be 17.5%.

An attempt has been made to apportion industrial sector R&D expenditure between different objectives laid down by UNESCO. As per the guidelines issued by them, each research project has to be assigned to some specific objective but due to operational problems it has not been possible to do so. Therefore, each industry has been assigned to a particular objective based on its major activity .On the basis of this criteria, the percentage allocation for various objectives arranged in descending order for the year 1988-89 is given in Table 1.5.

Table 1.5
PERCENTAGE DISTRIBUTION OF INDUSTRIAL SECTOR R&D EXPENDITURE BY MAJOR AIMS IN 1988-89

Aim	Percentage share
Promotion of Industrial Development	49.2
Defence	18.6
Development of Transport & Communication	10.4
Production, Conservation & Distribution of Energy	9.9
Development of Health Services	8.2
Other aims	3.7

As can be seen from Table 1.5, more than three fourth of total industrial sector R&D expenditure was shared by three objectives - "Promotion of Industrial Development", "Defence", and "Development of Transport and Communication".

An attempt has also been made to apportion industrial sector R&D expenditure by different fields of science. About 66.2% of total industrial sector R&D expenditure during 1988-89 was in field of Engineering and Technology. This was followed by Natural Sciences which accounted for 23.6% of total industrial sector R&D expenditure and rest 10.2% was shared by in Medical and Agricultural Science. The table given at the end showing expenditure by fields of science may be referred in this context.

The breakup of industrial sector R&D expenditure in revenue (recurring) and capital expenditure was available for Rs.670.28 crores during 1988-89. Revenue expenditure on R&D increased from Rs.347.40 crores in 1986-87 to Rs.475.95 crores in 1988-89 showing an increase of about 37.0% in two years whereas Capital expenditure for the same period increased from Rs.149.26 crores to Rs.194.33 crores showing an increase of about 30.0%. During 1988-89 about 68.2% of total industrial sector R&D expenditure was accounted for by revenue expenditure, about 27.8% was accounted by the capital expenditure and for rest 4% the information was not available. It may be appropriate to mention here that most of the industries in private sector were not maintaining separate accounts for revenue and capital expenditure on R&D so it was difficult to get this information for all the industries. The table at the end may be referred in this context.

Another major indicator to point out the extent of country's R&D effort is the quantum of S&T manpower deployed on R&D activities. As on 1st April, 1988, 2,67,616 personnel were employed in all R&D establishments in the country. Out of this,23.5% or 62,926 personnel were employed in 949 R&D units of the industrial sector comprising of both public and private sector.This figure comprises of both full time and full time equivalent of personnel employed on part time basis. About 56.1% were employed in 828 in-house R&D units of private sector and the rest 43.9% were employed in 121 public/joint sector R&D units.

The S&T personnel employed in R&D units of industrial sector were either engaged in research and development work or were extending technical support for research and development (termed as auxiliary personnel) or provided administrative support for research activities. The break up of these personnel into three categories has been provided in Table 1.6 separately for public sector, private sector and industrial sector. In case of public sector, data for auxiliary and administrative personnel and for private sector,data for administrative personnel for large number of industries were not available and therefore data of the previous survey have been used. It may also be mentioned here that the classification of total personnel into three categories was not easy for many in-house R&D units and therefore, this data may be considered only as order of magnitude.

Table 1.6

CLASSIFICATION OF R&D PERSONNEL BY TYPE OF WORK

Category	Public Sector	Private Sector	Industrial Sector
R&D	12652	18493	31145
Auxiliary	9747 *	10323	20070
Administration	5212 *	6499 *	11711
Total	27611	35315	62926

* Figures of 1984-85 survey repeated.

It may be seen from Table 1.6 that for every 100 personnel employed in industrial sector, 49 were engaged in research, 32 provided technical support for performing R&D work and 19 extended administrative support. In private sector 53 out of every hundred personnel were engaged in research, 29 provided technical support and 18 provided administrative support and for public sector employment,the share of these categories was 46,35 and 19 respectively.

As on 1st April, 1988 the total number of R&D personnel employed in 949 industrial sector R&D units was estimated at 31,145 which works out to be 32% of total R&D personnel employed at national level. Out of 31,145 R&D personnel, 59.4% were employed in 828 private sector industries and rest 40.6% were employed in 121 public/joint sector companies.

On the basis of the response to the questionnaire about 17,999 women personnel were employed in the R&D institutions in the country including the in-house R&D units of the public and private sector companies except academic sector. Out of this about 17.3% (3109 personnel) were employed in the in-house R&D units of industrial establishments. Out of 5552 female S&T personnel directly engaged on R&D activities on the national level, the share of industrial sector was about 27.6%. It is seen that for every 1000 R&D employees in industrial sector about 49 were female R&D employees. Out of total females in industrial sector, about 65.1% were employed in private sector in-house R&D units and rest 34.7% were in public sector.

A comparison has been attempted on the basis of level of qualifications between institutional and industrial sector and the same may be seen from Table 1.7. Classification by level of qualifications was not available for all R&D personnel.

Table 1.7
CLASSIFICATION OF R&D PERSONNEL IN THE INDUSTRIAL AND INSTITUTIONAL SECTOR BY LEVEL OF QUALIFICATIONS

Qualifications	Institutional Sector	Industrial Sector
Ph.Ds	8289	2048
Post Graduates	14346	6054
Graduates	7643	11403
Diploma & Others	10513	11383
Total	40791	30888

Out of 71,679 R&D personnel whose qualifications were known, 56.9% were employed in the institutional sector and 43.1% were employed in the industrial sector. It may be seen from Table 1.7 that for every 100 R&D personnel employed in industrial sector, 7 had Ph.D degree, 19 had post graduate degree, 37 had graduate degree and the same proportion had "diploma or other" qualifications whereas the proportion of Ph.D's and post graduates were higher in the institutional sector but proportion of graduates and "diploma and other" qualifications was more in Industrial sector. It may be appropriate to conclude from this that institutional sector was employing more qualified personnel on R&D when compared to industrial sector.

Table 1.8 gives information on the percentage distribution of total number of R&D personnel employed in public and private sector by level of qualifications. Classification by level of qualifications was not available for all R&D personnel.

Table 1.8
PERCENTAGE DISTRIBUTION OF TOTAL NUMBER OF R&D PERSONNEL IN THE PUBLIC & PRIVATE SECTOR BY LEVEL OF QUALIFICATIONS

	Qualification			
Sector	Ph.D	Post Graduate	Graduate	Diploma & Others
Public Sector	5.4	16.6	33.6	44.4
Private Sector	7.5	21.7	39.2	31.6

It may be seen from Table 1.8 that the proportion of Ph.Ds, Post graduates and graduates were more in private sector when compared to public sector whereas the proportion of diploma and other qualifications was more in case of public sector. It appears from the above analysis that private sector was employing more qualified R&D personnel when compared to public sector.

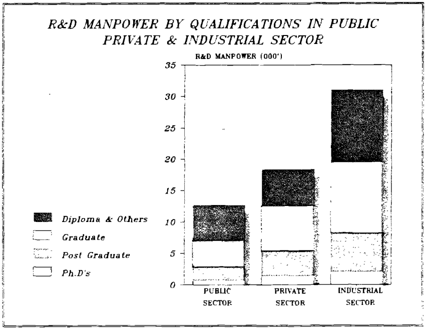

R&D MANPOWER BY QUALIFICATIONS IN PUBLIC PRIVATE & INDUSTRIAL SECTOR

Table 1.9 gives the total number of R&D personnel employed in the industrial and institutional sector by field of specialisation. Data for area of specialisation were not available for all R&D personnel.

Table 1.9
DISTRIBUTION OF R&D PERSONNEL IN THE INSTITUTIONAL & INDUSTRIAL SECTOR BY FIELD OF SPECIALISATION

Field	Institutional Sector	Industrial Sector
Natural Sciences	12,245	8354
Agricultural Sciences	15,907	399
Engineering/Technology	10,627	21441
Medical Sciences	1093	401
Social Sciences	919	293
Total	40,791	30888

It was interesting to note from Table 1.9 that engineering/technology dominate over all other disciplines in the industrial sector and in case of institutional sector, agricultural science dominates over all other disciplines. About 69.4% of total personnel employed in industrial sector were from the area of engineering/technology, 27.0% from natural sciences and the rest from agriculture, medical and social sciences. In case of institutional sector about 39.0% of total institutional sector employed were from the areas of agricultural sciences, 30.0% from natural science, 26.0% from engineering/technology and rest from social and medical sciences. The dominance of agricultural scientists in R&D in case of institutional sector can be attributed to agricultural universities. It appears from this that R&D in industrial sector was more stressed towards applied sciences when compared to institutional sector.

A comparison of R&D personnel by field of specialisation has been made between public and private sector industries in Table 1.10. This table provides information on the total number of R&D personnel employed in public, private and industrial sector by disciplines. Out of 31145 R&D personnel employed in industrial sector, information regarding classification by discipline was available for 30888.

Table 1.10

DISTRIBUTION OF R&D PERSONNEL IN THE INDUSTRIAL SECTOR BY FIELD OF SPECIALISATION

Disciplines	Public Sector	Private Sector	Industrial Sector
Natural Sciences	2025	6329	8354
Agricultural Sciences	34	365	399
Engineering & Technology	10435	11006	21441
Medical Sciences	14	387	401
Social Sciences	89	204	293
Total	12597	18291	30888

It may be seen from Table 1.10 that the discipline of engineering and technology dominate over all other disciplines in industrial sector as a whole as well as in the public and private sector separately which accounted for 69.4%, 82.8% and 60.2% respectively. Next to this comes natural sciences which accounted for 27.0%, 16.1% and 35.0% respectively. It may be appropriate to conclude from the above analyses that R&D in the industrial sector was more stressed towards the applied sciences.

Out of 31145 R&D personnel employed in the industrial sector information about salary scales were available in respect of 29078, i.e. about 93.4%.

The relevant tables containing data on salary scales in respect of public and private sector are given at the end and these may be referred appropriately. There are no well defined salary scales available for private sector industries and so it is difficult to compare salaries of public and private sector industries. In order to make it comparable, the industries were approached to provide information on the salary scales prescribed in the survey questionnaire. The scales were made uniform by keeping a difference of Rs.1000 between each scale. However in some cases it is seen that the information provided by both public and private sector industries indicate total emoluments rather than salary scales. Therefore the data provided at the end may be used with caution. Some of the interesting points emerging out of the analyses are given in the ensuing paragraph.

Almost half of the R&D personnel employed in public sector were in the scale between Rs.1000 to Rs.2000. Only 12.5% of total R&D personnel in public sector where in the scales less than Rs.1000. In case of private sector a little less than one third of total R&D personnel were in the scales upto Rs.2000. About 45% were in the scales between Rs. 2000 to Rs. 4000. A little less than one fourth of total R&D personnel were in the pay scales of more than Rs.4000.

To sum up, the salient features are as follows:

- Industrial sector accounted for 20.9% of the total national expenditure on R&D activities during the year 1988-89 and constituted 0.21% of GNP
- The total R&D expenditure at current prices was Rs.725.11 crores for 1988-89.
- The industrial units spent about 0.72% of their sales turnover on R&D in 1988-89.
- About one fourth of total industrial sector R&D units which belonged to Defence,Electricals & Electronics and Metallurgical groups accounted for about one half of the total industrial sector R&D expenditure.
- About one half (49.2%) of total industrial sector R&D expenditure was spent on the objective Promotion of Industrial Development during 1988-89.
- 62926 S&T personnel were employed in 949 industrial sector in-house R&D units out of which 31145 were engaged in R&D activities which works out to be about 32% of total R&D personnel employed at national level. Out of the total 31145 R&D personnel in industry,59.4% were employed in private sector and rest 40.6% were employed in public sector.
- For every 1000 R&D employees in industrial sector, 49 were female R&D employees.
- Institutional sector had deployed more qualified personnel on R&D than industrial sector.
- Private sector had deployed more qualified personnel on R&D as compared to public sector.
- Engineering personnel accounted for 69.4% of total industrial sector R&D personnel.
- A little more than one fourth of total industrial sector personnel primarily engaged on R&D activities were having Post graduate or above qualifications.

R & D
IN
PRIVATE SECTOR

CHAPTER-II

R&D IN THE PRIVATE SECTOR

This chapter is entirely devoted to data and analyses of inputs both human and financial devoted to research and development activities by in-house R&D units of the private sector. The detailed tables containing data are given at the end and these may be referred appropriately while going through the rest of the chapter. In all, questionnaire were sent to 895 private sector in-house R&D units and 828 R&D units have sent the requisite data. R&D expenditure for the remaining 67 in-house R&D units have been projected to arrive at the total private sector R&D expenditure. However, the analyses of data in respect of R&D expenditure by industry groups, by field of science, by objectives, by states and by R&D manpower are restricted to the actual data received from 828 private sector in-house R&D units.

It may not be out of place to mention here that in the industrialised countries, investment on research and development by private sector industries is more or equal to that of investment made by the government sector whereas, in India 89.5% of total expenditure on R&D activities is borne by the government. It may perhaps be due to the fact that the spirit of competition which compels industries to undertake R&D in the advanced countries of world for their very survival does not by and large exist in this country as India is still a sellers' market. The R&D expenditure in the industry is stimulated by industries interested to commercialise their R&D results. The areas in which these have happened would include import substitution increasing sales through cost reduction and diversification to new products. In order to make the Indian industry to take up more and more indigenous R&D work, the Government of India has been giving encouragement to industries for setting up the in-house R&D units through several measures . A scheme for granting recognition to in-house R&D units in industrial sector has been in operation since 1973. Presently, this scheme is being handled by the Department of Scientific and Industrial Research. One of the objectives of this scheme is to provide liberalised import facilities to recognised R&D units for equipping their laboratories with equipment, components, raw material etc. necessary to carry out research and development work.

These measures have encouraged industrial units to establish in-house R&D centres which is quite apparent from Table 2.1 as it gives information on the growth of the industrial in-house R&D units during the various plan periods. This information was available for 799 R&D units of private sector.

Table 2.1

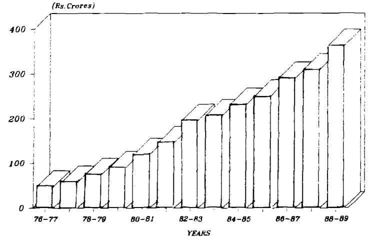
GROWTH OF R&D UNITS IN THE PRIVATE SECTOR

Sl.No.	Period	Private Sector
1.	Pre-Independence	9
2.	August, 1947 to 1960-61	35
3.	Third Five Year Plan(1961-62 to 1965-66)	53
4.	Annual Plans(1966-67 to 1968-69)	40
5.	Fourth Five Year Plan(1969-70 to 1973-74)	162
6.	Fifth Five Year Plan(1974-75 to 1978-79)	189
7.	1979-80 to 1983-84	215
8.	1984-85 to 1988-89	96
	Total	799

It may be interesting to see from Table 2.1 that only 5.5% of the industries in the private sector had their R&D set up before third five year plan. About 82.8% of total in-house R&D units came into existence during the Fourth Five Year Plan period and later. The peak was observed during the years 1979-80 to 1983-84 when about 26.9% of industries had set up their in-house R&D units. Next to this comes the fifth five year plan and fourth five year plan when about 23.6% and 20.3% had set up their R&D units. Incidentally the registration scheme of Department of Science and Technology was also started in fourth five year plan period. It may not be wrong to infer from the above analyses that the measures taken by the government have had effect in setting up of R&D centres by private sector companies.

Investment on research and development by private sector in-house R&D units for the year 1988-89 attained a level of Rs.363.78 crores at current prices, which works out to be about 10.5% of total investment in R&D at National level. The private sector R&D expenditure as percentage of sales turnover worked out to be 0.62% for the year 1988-89. The private sector R&D expenditure for the year 1988-89 worked out to be 0.11% of the Gross National Product.

GROWTH OF PRIVATE SECTOR R&D EXPENDITURE FROM 1976-77 TO 1988-89



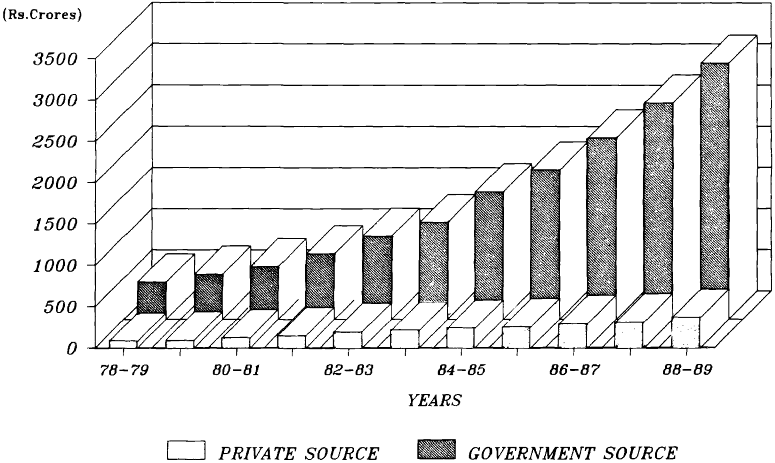
The growth of investment on R&D by private sector in-house R&D units from 1978-79 to 1988-89 may be seen from the graph. The R&D expenditure has increased from Rs.75.87 crores in 1978-79 to Rs. 120.69 crores in 1980-81 to Rs. 291.63 crores in 1986-87 to Rs.310.27 crores in 1987-88 and to Rs.363.78 crores in 1988.89. The projected figure for R&D expenditure for the year 1989-90 was of the order of Rs. 436.54 crores. This figure was calculated on the basis of the growth rates observed so far. The growth of R&D expenditure of 1988-89 over the previous year was about 17.2% whereas, the growth of 1987-88 over 1986-87 was only 6.4%. At 1980-81 prices the growth of 1988-89 over the previous year was 9.2%. However, at constant prices 1985-86 R&D expenditure shows a decline of 0.02% over the previous year.

Investment by private source and Government source on R&D from 1978-79 to 1988-89 has been delineated in Table 2.2.

Table 2.2
TREND OF R&D EXPENDITURE BY SOURCE OF FUNDS

Year	R&D Expenditure (Rs.crores)	
	Private Source	Government Source
1978-79	75.87	452.73
1979-80	92.14	546.40
1980-81	120.69	639.83
1981-82	147.00	793.73
1982-83	196.98	1009.05
1983-84	207.83	1173.27
1984-85	233.19	1548.36
1985-86	251.94	1816.84
1986-87	291.63	2204.24
1987-88	310.27	2626.67
1988-89	363.78	3108.02

EXPENDITURE ON RESEARCH & DEVELOPMENT BY SOURCE FROM 1978-79 TO 1988-89



Note:Private source includes private sector industries only.
Government source includes institutional sector and public sector industries

It may be noted from Table 2.2 that the proportion of private sector R&D expenditure in total national R&D expenditure has increased from 14.3% in 1978-79 to 15.9% in 1980-81 to 16.3% in 1982-83 and has decreased to 13.1% in 1984-85 to 11.7% in 1986-87 and to 10.5% in 1988-89. The decrease in the proportion of private sector expenditure during 1983-84 to 1988-89 may be attributed to higher annual growth in R&D expenditure of government sector when compared to private sector during this period. It may be seen from Table 2.2 that the annual growth rate of private sector R&D expenditure for 1982-83 over 1981-82 was 34% and and this has gone down to 17.2% for the year 1988-89 over 1987-88 whereas, the growth rate of government sector R&D expenditure during the same period has gone down from 27% to 18.3%. It may be worth noticing that over a period of eleven years i.e. from 1978-79 to 1988-89 the private sector investment on R&D has increased about five times whereas Government sector investment on R&D has increased about seven times. It may be worth mentioning here that the share of private sector R&D expenditure in national R&D expenditure for industrially advanced countries was more than 50%, whereas this was only 10.5% for India for 1988-89.

It is known that industries are profit oriented and investment by industrial units on any venture are to a large extent conditioned by the likely financial benefits in terms of increasing sales, cost reduction and diversification to new products. Investment on R&D, advertising and new plant and equipment aims at increase in sales and production. Therefore, in order to assess the relative importance given by industries to R&D, advertising and purchase of new machinery and also to study the pattern of these indicators, the information regarding R&D expenditure as percentage of sales turnover, advertising expenditure and expenditure on new plant and machinery and their share in sales turnover have been compiled and presented in Table 2.3 for eleven years period.

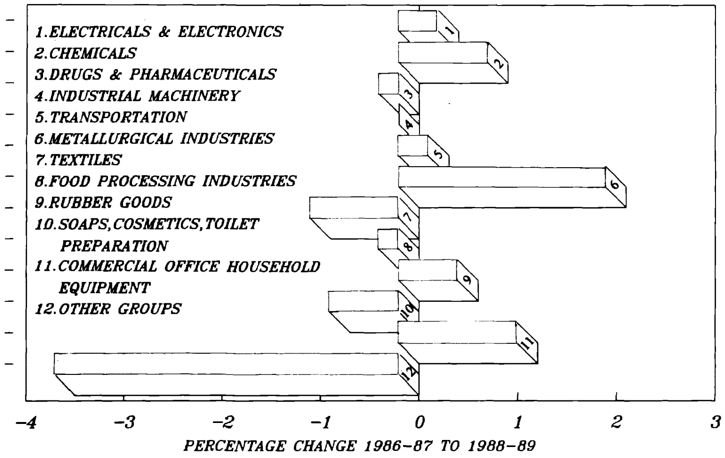
Table 2.3

R&D EXPENDITURE, EXPENDITURE ON ADVERTISING AND EXPENDITURE ON NEW PLANT & MACHINERY AS PERCENTAGE OF SALES TURNOVER

Year	R&D Expenditure as percentage of sales turnover	Advertising Expenditure as percentage of sales turnover	New Plant & Machinery Expenditure as percentage of sales turnover
1978-79	0.79	0.33	2.63
1979-80	0.85	0.31	2.53
1980-81	0.77	0.32	2.97
1981-82	0.76	0.32	3.08
1982-83	0.50	0.25	2.74
1983-84	0.52	0.26	3.09
1984-85	0.72	0.35	3.56
1985-86	0.70	0.42	3.40
1986-87	0.64	0.54	5.29
1987-88	0.58	0.54	5.29
1988-89	0.62	0.53	2.94

It may be interesting to note from Table 2.3 that R&D expenditure as percentage of sales turnover had increased from 0.79% in 1978-79 to 0.85% in 1979-80, had decreased to 0.50% in 1982-83, again increased to 0.72% in 1984-85 and decreased to 0.62% in the year 1988-89. No doubt, there has been an upward trend in R&D spending during this period but the growth rate of sales turnover was more in some years when compared to that of the R&D expenditure and because of this the ratio of R&D expenditure to sales turnover was also less. It is however, pertinent to mention here that R&D expenditure as percentage of sales

INDUSTRY GROUPWISE CHANGE IN SHARES OF R&D EXPENDITURE IN PRIVATE SECTOR FROM 1986-87 TO 1988-89



turnover for most of the advanced countries ranges between 2% to 4%. It may also be noted from Table 2.3 that the expenditure on advertising as percentage of sales turnover was showing more or less decreasing trend upto the year 1983-84 and showed an increase in the subsequent years. This ratio was always less than the R&D sales turnover ratio. However, the private sector expenditure on purchase of new plant and machinery as percentage of sales turnover was more than R&D as percentage of sales (2.94%) during 1988-89 and also in all the years. It may be appropriate to conclude that private sector industries were giving more importance to purchase of new plant and equipment and R&D than to advertising.

The private sector expenditure on R&D was apportioned to 38 industrial groups on the basis of products manufactured by them. Table 2.4 clearly shows that the eleven industry groups - Electricals and Electronics, Chemicals (other than fertilizers), Drugs and Pharmaceuticals, Industrial Machinery, Transportation, Metallurgical Industries, Textiles, Food Processing, Rubber Goods, Soaps, Cosmetics and Toilet Preparations and Commercial Office and Household Equipment spent 84.1% of the total R&D expenditure of private sector during 1988-89.

Table 2.4

INVESTMENT BY PRIVATE SECTOR IN R&D BY MAJOR INDUSTRY GROUPS IN 1988-89

Sl. No.	Industry Group	No.of Units	Expenditure on R&D (Rs. lakhs) 1988-89	Percentage Annual growth rate 1988-89 over 1986-87
1.	Electricals & Electronics	146	5577.50	12.9
2.	Chemicals (other than Fertilizers)	156	5336.61	14.7
3.	Drugs & Pharmaceuticals	78	5177.49	10.8
4.	Industrial Machinery	79	2720.72	11.4
5.	Transportation	35	2419.25	14.1
6.	Metallurgical Industries	56	2263.64	34.8
7.	Textiles(Dyed, printed & Processed	27	1213.64	(-)0.002
8.	Food Processing Industries	20	1091.58	8.4
9.	Rubber Goods	13	966.61	24.0
10.	Soaps,Cosmetics,Toilet Preparations	7	840.56	(-)0.02
11.	Commercial Office Household Equip.	6	695.61	73.7
12.	Other Groups	205	5352.06	1.6
	Total	828	33655.27	11.7

It would be evident from Table 2.4 that about 16.6% of total private sector investment on R&D was shared by 146 in-house R&D units in Electricals and Electronics Group, 15.9% by 156 units in Chemicals (other than fertilizers) group, 15.4% by 78 units in the group of Drugs and Pharmaceuticals, 8.1% by 79 units in Industrial Machinery, 7.2% by 35 units in Transportation group and 6.7% by 56 units in Metallurgical industries. These six industry groups accounted for 69.9% of total private sector R&D expenditure. It would be advisable that while interpreting these results the number of R&D units in each industry group should be kept in mind. It may further be seen from Table 2.4 that the figures of annual rate of growth shows that in case of five industry groups - Chemicals (other than Fertilizers), Electricals and Electronics, Transportation, Metallurgical Industries, Rubber Goods and Commercial Office & Household Equipment, the growth rates were more than the overall growth rate. The graph may also be seen which shows the percentage distribution of number of industries and percentage change in the share of R&D investment.

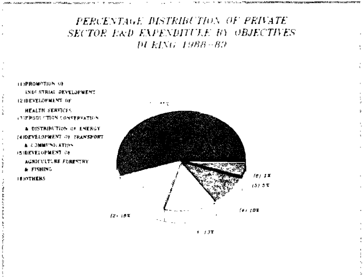
The expenditure incurred by the private sector on R&D has been apportioned as per major aims identified by UNESCO. The distribution of total R&D expenditure by major aims in descending order is given in Table 2.5 for the year 1988-89.

Table 2.5

DISTRIBUTION OF R&D EXPENDITURE BY OBJECTIVES DURING 1988-89

Aims	R&D Expenditure (Rs.crores)
Promotion of Industrial Development	185.11
Development of Health Services	52.90
Production, Conservation & Distribution of Energy	44.48
Development of Transport and Communication	34.43
Development of Agriculture, Forestry & Fishing	17.68
Others	1.95
Total	336.55

It may be interesting to note from Table 2.5 that almost 100% of total private sector R&D expenditure was accounted for by the objectives, promotion of Industrial Development, Development of Health Services, Production, Conservation and distribution of energy, Development of Transportation and Communication and Development of Agriculture Forestry and Fishing in that order. More than one half (55%) of total R&D expenditure was accounted for by the aim, promotion of Industrial Development followed by development of health services (15.7%). These two objectives accounted for 70.7% of total private sector R&D expenditure.



An attempt has been made to apportion the total private sector R&D expenditure by different fields of science. During 1988-89 about 55% of total R&D expenditure was in the field of Engineering & Technology, 26.2% in Natural Sciences, 15.8% in Medical Sciences and 3% in Agricultural Sciences. The table at the end showing the R&D expenditure for private sector by field of science for the year 1986-87, 1987-88 and 1988-89 may be seen.

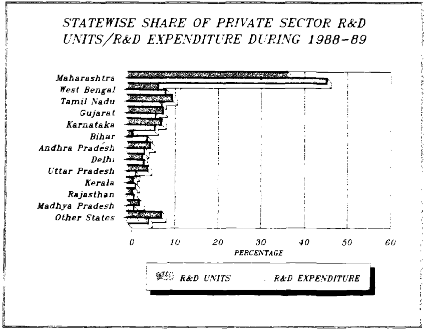
The information regarding the breakup of total R&D expenditure into Revenue and Capital expenditure was available for Rs.326.80 crores during 1988-89. Out of this 68% was accounted for by the revenue expenditure and rest 32% was accounted for by the capital expenditure. The table given at the end showing capital and revenue expenditure for three years period may be referred in this context. It may be mentioned here that a number of private sector in-house R&D units were not maintaining separate accounts for revenue and capital expenditure so it was difficult to get these figures for all the units.

An attempt has been made to classify R&D expenditure by different States and Union Territories based on the location of R&D centre. The information on the dispersal of private sector in-house R&D units in various States and Union Territories and their share in the total R&D expenditure in descending order of magnitude during 1988-89 has been presented in Table 2.6. It may be appropriate to mention here that some of the industries have their R&D centres located in more than one place in the same State or in different States and due to non availability of data on breakup of R&D expenditure separately in respect of each R&D centre, the entire expenditure had been booked against only one R&D centre.

Table 2.6
STATE-WISE INVESTMENT ON R&D BY PRIVATE SECTOR DURING 1988-89

Sl. No.	Name of the State	Number of Industries	Expenditure on R&D (Rs.Lakhs) 1988-89
1.	Maharashtra	308	15555.85
2.	West Bengal	60	3004 46
3.	Tamil Nadu	87	2673.43
4.	Gujarat	69	2173.67
5.	Karnataka	66	2074.34
6.	Bihar	11	1567.94
7.	Andhra Pradesh	46	1332.98
8.	Delhi	30	1319.14
9.	Uttar Pradesh	39	645.42
10.	Kerala	11	617.29
11.	Rajasthan	11	545.81
12.	Madhya Pradesh	24	491.10
13.	Others	66	1653.83
	Total	828	33655.26

It may be seen from Table 2.6 that (72.6%) of total R&D units were located in Maharashtra, West Bengal, Tamil Nadu, Gujarat, Karnataka and Bihar accounting for about 80.4% of the total R&D expenditure in 1988-89. Out of this about 37.2% of industries accounting for 46.2% of the total R&D expenditure were located in the State of Maharashtra alone. Other States which had sizeable number of R&D units and R&D expenditure were West Bengal, Tamil Nadu, Gujarat and Karnataka. It may also be noted from this table that in case of the R&D units located in the States of Maharashtra, West Bengal, Bihar, Delhi, Kerala and Rajasthan the percentage share of R&D expenditure in total R&D expenditure was either more or equal to their respective percentage share of R&D units in the total R&D units. However, in case of other States the situation was reverse.


STATEWISE SHARE OF PRIVATE SECTOR R&D UNITS/R&D EXPENDITURE DURING 1988-89

The R&D expenditure incurred by in-house R&D units of small scale industries during 1987-88 and 1988-89 has been given in Table 2.7 for some major industry groups based on the products manufactured by them. Out of the 828 private sector in-house R&D units which responded to the questionnaire, 215 in-house R&D units were in small scale sector and rest 613 units were medium or large scale units.

Table 2.7
R&D EXPENDITURE BY INDUSTRY GROUPS FOR SMALL SCALE SECTOR INDUSTRIES

Sl. No.	Industry Group	Number of Industries	Total R&D Expenditure (Rs.Lakhs) 1987-88	1988-89
1.	Electronics & Electricals Equipment	55	403 49	636.19
2.	Industrial Machinery	17	272.05	312.31
3.	Food Processing Industries	8	219.76	241.38
4.	Chemicals (other than Fertilizers)	46	189.69	220.50
5.	Drugs & Pharmaceuticals	18	161.22	148.32
6.	Telecommunication	23	137.02	123.79
7.	Industrial Equipment	16	88.63	72.96
8.	Metallurgical Industries	7	70.25	63.18
9.	Misc.Mech.Engineering Industries	2	36 14	38.38
10.	Machine Tools	4	25.70	36 18
11.	Scientific Instruments	7	23.98	32.90
12.	Other Groups	12	83.20	68.84
	Total	215	1711 13	1994.93

As shown in Table 2.7 expenditure on R&D by these industries has increased from Rs.17.11 crores in 1987-88 to 19.95 crores 1988-89 showing an increase of about 16.6% in one year. Out of the 38 industry groups identified it appears only 19 industry groups had small scale industries performing R&D work and out of this 11 major groups were shown in Table 2.7. A little more than one fourth of total industries were in small scale sector and these industries were responsible for 5.9% of the total private sector investment on R&D during 1988-89. It may be interesting to note that about 85.1% of total R&D units in small scale sector were under Electricals and Electronics, Industrial Machinery,Food Processing, Chemicals (other than Fertilizers) Drugs and Pharmaceuticals, Telecommunication and Industrial Equipment group accounting for about 88% of total expenditure. It may further be noted from this table that in case of industries under Electricals and Electronics,Food Processing,Industrial Machinery and Miscellaneous Mechanical Engineering Industry groups, percentage share of their total number of in-house R&D units was less than their respective percentage share of R&D expenditure whereas, in case of other groups it was just the reverse. It may be seen from tables given at the end that the ratio of R&D expenditure to sales turnover in case of small scale industries was more than the medium and large scale industries. This may be due to two reasons. The small scale industries may be giving more importance to R&D compared to medium and large scale industries; the small scale industries sales turnover may not be as high as that of medium or large scale industries.

Table 2.8

CLASSIFICATION OF PRIVATE SECTOR R&D UNITS ON THE BASIS OF EXPENDITURE INCURRED ON R&D DURING 1988-89

Sl. No.	Range of Expenditure per unit (Rs.Lakhs)	Number of Units	R&D Expenditure (Rs. Lakhs)
1	0-10	362	1491.40
2	10-20	166	2344.44
3	20-30	66	1670.28
4	30-50	71	2813.48
5	50-100	83	5865.32
6	100-200	43	6105.72
7	200-400	23	5907.19
8	More than 400	14	7457.43
	Total	828	33655.26

The number of in-house R&D units have been classified under various ranges of expenditure incurred by them during 1988-89 and the same has been presented in Table 2.8. This table also gives the total expenditure in each range.

It may be seen from Table 2.8 that 71.7% of total in-house R&D units spending Rs.30 lakhs or less each accounted for 16.4% of total private sector investment on R&D whereas, about 4.5% of the units spending more than Rs.200 lakhs each accounted for about 39.7% of the total investment on R&D during 1988-89. About 19.7% of the total industries were spending more than Rs.50 lakhs each on R&D and rest 80.3% were spending less than this amount. About 9.7% of the total industrial R&D units were spending more than one crore each on R&D activities.

Financial and human resources directed to industrial R&D represent principal "inputs" to R&D and in a way can be used as approximate indicators of the magnitude of the R&D effort. R&D "intensity" of the industry may be measured by using the quantum of human and financial resources utilized on R&D. The indices used to quantify the R&D intensity are (i) R&D expenditure as percentage of sales turnover, (ii) the number of personnel employed in R&D per thousand employees. Based on the level of intensity arrived at by using the above two indices, an attempt has been made to classify industry groups into three categories.The assumption made to categorise these groups was that the industrial groups which devote comparatively higher percentage of sales turnover on R&D and deploy sizeable number of R&D personnel per thousand employees were categorised as the most R&D intensive and as such were placed in the first category. On the same basis the industrial groups having comparatively lower figures for both of the indices were placed in the third category. The rest of the groups were placed in the second category which was medium R&D intensive. Table 2.9 gives category-wise information on industries classified by R&D intensity indices.

Table 2.9
R&D INTENSITY IN PRIVATE SECTOR, 1988-89

Sl. No.	Industry Group	R&D Expenditure as % of Sales turnover	R&D Personnel per thousand employees
CATEGORY-I			
1.	Math, Surveying & Drawing Instruments	3.93	24
2.	Medical & Surgical Appliances	2.06	48
3.	Industrial Instruments	1.89	59
4.	Drugs & Pharmaceuticals	1.60	27
5.	Telecommunications	1.37	81
6.	Prime Movers	1.60	18
7.	Commercial Office & Household Equip.	1.03	19
8.	Electricals & Electronics	1.01	28
9.	Chemicals (other than Fertilizers)	0.97	31
10.	Dyestuff	0.93	38
11.	Scientific Instruments	0.86	21
CATEGORY-II			
1.	Food Processing Industries	1.34	8
2.	Ceramics	1.26	14
3.	Transportation	0.69	17
4.	Photographic Raw Film & Paper	0.68	24
5.	Miscellaneous Mechanical Engg.Industries	0.65	22
6.	Agricultural Machinery	0.57	16
7.	Soaps,Cosmetics & Toilet Preparations	0.50	11
8.	Fertilizers	0.48	24
9.	Fuels	0.47	28
10.	Glass	0.45	13
11.	Boilers & Steam Generating Plants	0.34	28
CATEGORY-III			
1.	Cement & Gypsum Products	0.56	4
2.	Sugar	0.44	10
3.	Timber Products	0.42	4
4.	Metallurgical Industries	0.39	6
5.	Rubber Products	0.35	9
6.	Paper & Pulp	0.35	8
7.	Textiles	0.35	5
8.	Earth Moving Machinery	0.25	22
9.	Machine Tools	0.21	34
10.	Industrial Machinery	0.25	18
11.	Fermentation Industries	0.19	15
12.	Miscellaneous Industries	0.13	6
13.	Glue & Gelatin	0.11	7
14.	Vegetable Oils & Vanaspati	0.08	12

It may be noted from Table 2.9 that within the different categories these indices were more or less consistent though exceptions were observed when comparison was made between the groups. To give a few examples of inconsistency, R&D expenditure index for industry groups Food Processing Industries and Ceramics in category II were comparable to that of industry groups in category I. R&D manpower index of Fuels, Boilers and Steam Generating Plants, Fertilizers, Photographic Raw Film and Paper and Miscellaneous Mechanical Engineering industries in category II was comparable to those in the first category. Within category I, industry group Telecommunications shows a high R&D manpower index with low R&D expenditure index as compared to other groups in the same category. In case of Fuels and Fertilizers in category II the R&D expenditure index was even less than category III whereas the R&D manpower index was more than category I industries. Similarly some of the groups in category III were comparable to category II for R&D expenditure or manpower index. Number of reasons can be given for this inconsistency and the main one could be that the number of R&D units in each group were not uniform and there were wide variations in respect of the sales turnover and total manpower figures as some of the groups included more number of small industries having low sales turnover and total manpower figures.It may be pointed out here that analyses attempted in Table 2.9 highlight, though in a limited way, some of the high R&D intensive industry groups.

An attempt has been made to find the relationship between the size of the industry measured in terms of total number of employees on the pay roll of the industry and the size of the R&D expenditure for the year 1988-89.

Table 2.10

CLASSIFICATION OF DIFFERENT COMPANIES ON THE BASIS OF THE TOTAL NUMBER OF PERSONNEL EMPLOYED BY THEM DURING 1988-89

Total Employment Size	Number of Units	Average per Unit R&D Expenditure (Rs.lakhs)
1-100	167	15.44
101-200	88	15.85
201-400	136	17.75
401-750	134	26.61
751-1500	119	41.24
1501-3000	90	61.90
3001 and more	94	140.67
Total	828	40.65

It may be seen from Table 2.10 that about one fifth of total R&D units were having total employees upto 100. Only about 11.3% of the units were having 3000 or more employees. It may be observed from Table 2.10 that the average per unit R&D expenditure was showing a consistent increase with the increase in the employment size of the companies .

Table 2.11 gives information on the total number of R&D units and average per unit R&D expenditure classified under different ranges of R&D personnel.

Table 2.11

NUMBER OF PRIVATE SECTOR R&D UNITS, PER UNIT R&D EXPENDITURE AND R&D EMPLOYMENT SIZE DURING 1988-89

R & D Personnel Employment Size	Number of Units	Average per Unit R&D Expenditure (Rs.lakhs)
1-20	595	16.07
21-40	135	47.60
41-60	35	113.44
61-80	20	162.05
81-100	9	328.82
101-120	7	135.09
121-140	6	235.89
141-160	4	342.19
161-180	5	235.92
181 and more	7	368.44
Information not available	5	2.03
Total	828	40.65

It may be seen from Table 2.11 that about 71.9% of total industries in private sector were employing 1-20 R&D personnel. Only 3.5% of total R&D units were employing more than one hundred R&D personnel. It may also be seen from this table that to a large extent R&D expenditure was showing a consistent increase with the increase of R&D employment size with some exceptions.

R&D personnel employed in in-house R&D units is another major indicator of the magnitude of the industrial R&D activities. As on 1st April, 1988 about 2,67,616 personnel were engaged in all R&D organisations in the country. Out of this 35,315 were working in the private sector in-house R&D units. The number of personnel employed on R&D activities in private sector amounting to 18493 were calculated on the basis of full time personnel and full time equivalent of part time personnel.

The personnel employed in R&D establishments of private sector were either engaged in research work or auxiliary activities or provided administrative support for research activities. The percentage breakup of these personnel into the above three categories was 52.4%, 29.2% and 18.4% respectively. The share of private sector R&D personnel in the total R&D personnel at the national level worked out to be about 19.1%.

At the national level 17,999 female personnel were estimated to be employed in all R&D establishments and out of this 2023 were employed in the private sector in-house R&D units. Out of 2023 female personnel employed in private sector R&D units about 943 were engaged in research activities. This worked out to be a mere 5.1% of the total private sector R&D personnel consisting of both male and female together. It is seen that for every 1000 R&D employees in the private sector about 51 were female R&D employees. Out of every 100 women R&D personnel employed in private sector, 46.6% were engaged in R&D activities 11.2% performed auxiliary activities and 42.2% performed non-technical jobs.

An attempt has been made to collect information on total salary drawn by the R&D personnel employed in the private sector in-house R&D units. The relevant table containing data on salary scales in respect of private sector R&D units is given at the end and this may be referred appropriately. Out of 18,493 R&D personnel employed in the private sector information about salary scales were available in respect of 17,176 i.e. about 92.9% . There are no well defined salary scales available in case of private sector industries. Keeping this in view the industries were approached to provide information on the salary scales prescribed in the survey questionnaire. It is observed from responses that the information provided by private sector industries in some cases indicate total emoluments rather than salary scales. Therefore the data given at the end may be used with caution. Some of the interesting points emerging out of the analyses are given in the ensuing paragraph.

About 31.5% of total R&D personnel were in the scales upto Rs.2000. About 44.5% were in the scales between Rs.2000 to Rs. 4000. A little less than one fourth of total R&D personnel were in the pay scales of more than Rs.4000.

Out of 18,493 persons deployed on R&D work in private sector, the discipline and qualifications were known for 18,291 persons. About 94.8% of this were qualified in engineering and technology and natural science fields. More than one half (60.2%) had engineering as their background. Next comes natural sciences which accounts for 34.6% of total R&D personnel. It may be appropriate to conclude from this that the majority of R&D personnel employed in private sector were either from engineering or natural sciences background. About 7.5% of total R&D personnel employed in private sector in-house R&D units were having Ph.D qualifications. 21.7% were having post graduate degree qualifications, 39.2% were having graduate degree qualifications and rest 31.6% were having either diploma or some other qualifications in natural scienes, engineering, agriculture, medical and social sciences. Out of 943 female R&D personnel employed in the in-house R&D units of private sector, discipline & qualifications were known for 937, about 5.6% were having Ph.D qualifications, 31.9% had post graduate qualifications, 44.8% were having graduate qualifications, and rest 17.7% were having diploma and other qualifications.

DISTRIBUTION OF R&D PERSONNEL BY
QUALIFICATIONS IN PRIVATE SECTOR
AS ON APRIL 1,1988

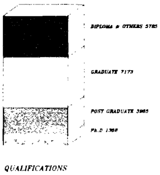


Table 2.12 gives percentage share of R&D personnel in different fields of science by qualifications they possessed.

Table 2.12

PERCENTAGE DISTRIBUTION OF R&D PERSONNEL IN DIFFERENT FIELDS OF SCIENCE BY QUALIFICATIONS

Sl. No.	Qualification/ Field of Science	Ph.D	Post Graduate	Graduate	Diploma & Others
1.	Natural Science	65.6	50.3	34.4	16.8
2.	Agricultural Sciences	4.2	2.9	1.7	1.2
3.	Engineering/Technology	25.6	43.0	60.5	79.7
4.	Medical Sciences	4.4	3.3	1.7	1.2
5.	Social Sciences	0.2	0.5	1.7	1.1
	Total	100.0 (1368)	100.0 (3965)	100.0 (7173)	100.0 (5785)

It may be seen from Table 2.12 that 65.6% of the total Ph.Ds employed in R&D departments of private sector had natural sciences as their discipline followed by engineering/technology with a little more than one fourth of the total Ph.Ds. Similarly in case of R&D personnel with post graduates, graduates, diploma and other qualifications also engineering and natural sciences dominates over the other disciplines. A broad inference may be drawn from the above analyses that majority of R&D personnel working in private industries were having qualification in engineering or natural sciences.

Table 2.13 gives percentage distribution of R&D personnel with different qualifications by major fields of specialisation.

Table 2.13

PERCENTAGE DISTRIBUTION OF R&D PERSONNEL WITH DIFFERENT QUALIFICATIONS BY FIELD OF SPECIALISATION

Sl. No.	Field of Science/ Qualifications	Natural Sciences	Agricultural Sciences	Engineering	Medical Sciences	Social Sciences
1.	Ph.D	14.2	15.9	3.2	15.5	1.5
2.	Post Graduate	31.5	31.0	15.5	34.1	9.8
3.	Graduate	38.9	34.2	39.4	32.1	57.8
4.	Diploma & Others	15.4	18.9	41.9	18.3	30.9
	Total	100.0 (6329)	100.0 (365)	100.0 (11006)	100.0 (387)	100.0 (204)

It may be interesting to note from Table 2.13 that 49.6% , 46.9% and 45.7% of total R&D personnel with medical sciences, agricultural sciences and natural sciences background were having Post graduate or above qualifications respectively. Whereas, in the case of social sciences, and engineering , R&D personnel with graduate or lower qualifications dominates over the other disciplines.

The total R&D personnel employed in private sector in-house R&D units have been classified by major industry groups.This information is provided in Table 2.14.

Table 2.14
DISTRIBUTION OF R&D PERSONNEL BY MAJOR INDUSTRY GROUPS

Sl. No.	Industry Group	Number of R&D Personnel
1.	Electricals & Electronics	3423
2.	Chemicals (other than Fertilizers	3062
3.	Drugs & Pharmaceuticals	1902
4.	Transportation	1682
5.	Industrial Machinery	1578
6.	Metallurgical Industries	926
7.	Textiles	527
8.	Food Processing Industries	508
9.	Rubber Goods	468
10.	Telecommunication	418
11.	Dyestuffs	408
12.	Agricultural Machinery	319
13.	Industrial Instruments	306
14.	Other Groups	2470
	Total	17997

About 80.5% of total private sector R&D personnel engaged in R&D activities were employed by industries under ten leading groups as listed in Table 2.14. First six groups accounted for more than two third of total R&D personnel. It might be inferred from this that R&D personnel in private sector R&D units were concentrated in a few industry groups.

To sum up, the salient features are as follows:

- Out of 895 in-house R&D units of private sector engaged in R&D activities during 1988-89, 82.8% came into existence during and subsequent to fourth five year plan.
- Investment on research and development by private sector in-house R&D units attained a level of Rs.363.78 crores in 1988-89 which was 17.2% more than the investment on R&D of previous year.
- Private sector R&D expenditure constitutes 10.5% of total investment in R&D at National level and it was 0.11% of GNP. About 0.62% of the sales turnover of private sector was spent on research and development.
- The industry groups Electricals & Electronics, Chemicals, Drugs & Pharmaceuticals, Industrial Machinery, Transportation and Metallurgical Industries accounted for 69.9% of total R&D expenditure during 1988-89.
- More than half (55%) of total R&D expenditure was utilised for the aim promotion of industrial development.
- About 68% of total R&D expenditure was accounted for by revenue expenditure and rest 32% was accounted for by capital expenditure.
- About 72.6% of total R&D units were located in the States of Maharashtra, West Bengal, Tamil Nadu, Gujarat, Karnataka and Bihar accounting for about 80.4% of total R&D expenditure in 1988-89. About 37.2% of the total R&D units were located in the State of Maharashtra alone and these units accounted for about 46.2% of total R&D expenditure.

- About 5.9% of total private sector R&D expenditure was accounted by a little more than one fourth of total industries in the small scale sector.

- About 80.3% of total industries were spending less than or equal to Rs.50 lakhs on R&D. About 9.7% of the total private sector R&D units were spending more than one crore each on R&D.

- The average per unit R&D expenditure was showing a consistent increase with the increase in the employment size of the companies.

- As on 1st April, 1988 about 35,315 personnel were employed in private sector industries. Out of this about 52.4% were engaged on R&D activities. The share of private sector R&D personnel in the total R&D personnel at the national level worked out to be about 19.1%.

- For every 1000 R&D employees in private sector, 51 were female R&D employees.

- Information regarding level of qualification were available for 18291 R&D personnel. Out of this 7.5% had Ph.D qualifications, 21.7% had post graduate qualifications, 39.2% had graduate qualifications and the rest 31.6% had diploma or other qualifications.

- About 60.2% of total R&D personnel had Engineering as their discipline.

- More than one third of total R&D personnel were employed in Electricals and Electronics and Chemicals group.

R & D
IN
PUBLIC SECTOR

CHAPTER-III
R&D IN PUBLIC SECTOR

This chapter of the report is entirely devoted to data and analyses of financial and human resources devoted to Research and Development by public sector industries (both at Central and State level).The detailed tables given at the end may be referred appropriately while going through the rest of this chapter. In all, R&D units of the 121 public sector/joint sector companies responded to the specially designed questionnaire. Out of this 83 belonged to Central Government and 38 belonged to State Governments.

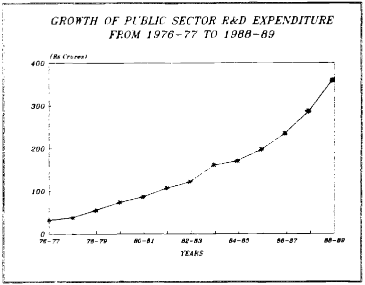
The information regarding the setting up of public sector in-house R&D units have been classified for various periods and the same may be seen from Table 3.1. The number of units shown in this table also include the joint sector companies mostly under the State Governments.

Table 3.1
GROWTH OF R&D UNITS IN PUBLIC SECTOR DURING DIFFERENT PERIODS

Sl.No.	Period	Number set up
1.	Pre-Independence	2
2.	August, 1947 to 1960-61	8
3.	Third Five Year Plan(1961-62 to 1965-66)	6
4.	Annual Plans(1966-67 to 1968-69)	5
5.	Fourth Five Year Plan(1969-70 to 1973-74)	23
6.	Fifth Five Year Plan(1974-75 to 1978-79)	27
7.	1979-80 to 1983-84	39
8.	1984-85 to 1988-89	11
	Total	121

It may be seen from Table 3.1 that about 82.6% of the in-house R&D units came into existence during the Fourth Five Year Plan period and subsequently. It may be observed from above that the need for undertaking research and development had been recognised by the big size public sector companies only during Fourth Five Year Plan.

Investment by public sector in-house R&D units on research and development activities for the year 1988-89 attained a level of Rs.361.32 crores at current prices which work out to be about 10.4% of total investment on R&D activities at national level. The investment on R&D by public sector has increased from Rs.86.36 crores in 1980-81 to Rs.161.66 crores in 1983-84 to Rs.198.62 crores in 1985-86 to Rs.235.70 crores in 1986-87 to Rs.288.46 crores in 1987-88 and to Rs.361.32 crores


GROWTH OF PUBLIC SECTOR R&D EXPENDITURE FROM 1976-77 TO 1988-89

in 1988-89. The projected figure for R&D expenditure for the year 1989-90 was of the order of Rs.415.51 crores. This figure has been calculated on the basis of the growth rates observed so far. The growth of R&D expenditure of 1988-89 over the previous year was 25.2% whereas the growth of 1987-88 over 1986-87 was 22.4%. At 1980-81 prices the growth of 1988-89 over the previous year was 16.7% and the growth of 1987-88 over 1986-87 was 12.6%.

Table 3.2 gives information on the growth of public sector R&D expenditure and its percentage share in national expenditure from 1976-77 to 1988-89.

Table 3.2
EXPENDITURE ON R&D BY PUBLIC SECTOR

Sl. No.	Year	Expenditure on R&D(Rs.crores)	Percentage growth in expenditure over the previous year	Percentage share in national R&D expenditure
1.	1976-77	31.76	-	8.1
2.	1977-78	37.50	18.1	8.3
3.	1978-79	55.19	47.2	9.9
4.	1979-80	73.41	33.0	10.9
5.	1980-81	86.37	17.6	10.6
6.	1981-82	107.55	24.5	10.7
7.	1982-83	122.46	13.9	10.2
8.	1983-84	161.66	32.0	11.7
9.	1984-85	171.22	5.9	9.6
10.	1985-86	198.62	16.0	9.6
11.	1986-87	235.70	18.7	9.4
12.	1987-88	288.47	22.4	9.8
13.	1988-89	361.32	25.2	10.4

It may be observed from Table 3.4 that there has been an upward *trend in the investment on R&D by the public sector industries, whereas* the annual growth rate had no clear trend. It may also be observed from this table that though R&D expenditure of public sector was showing an increasing trend in absolute terms,their share in total national R&D expenditure has declined from 10.9% in 1979-80 to 10.2% in 1982-83,increased in 1983-84 to 11.7%, declined to 9.4% in 1986-87 and started increasing later on. It may be appropriate to conclude from the above that the pace of growth of public sector R&D expenditure was slow when compared to total national R&D expenditure.

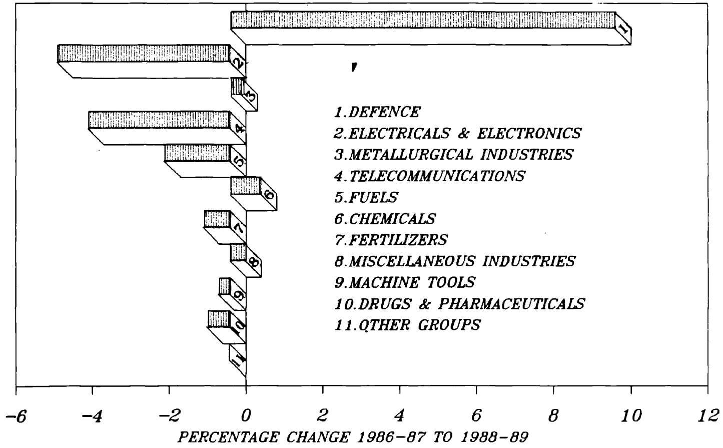
The information regarding R&D expenditure as percentage of sales turnover, advertising expenditure as percentage of sales turnover and purchase of new plant and machinery as percentage of sales turnover have been compiled. This information has been compiled to assess the relative importance given by the public sector R&D units to the above mentioned parameters. As may be seen from the table at the end, R&D expenditure in public sector was estimated to be 0.77% of their sales turnover during 1988-89. This was more than the percentage of advertising expenditure on sales turnover which was a mere 0.06% but the ratio of public sector expenditure on purchase of new plant and machinery to sales turnover was 2.84%. So it may be appropriate to conclude that the public sector in-house R&D units were giving higher priority to the purchase of new plant and equipment and also to R&D though at a lesser extent as compared to advertising.

An attempt has been made to apportion public sector R&D expenditure into 38 industry groups on the basis of products manufactured by them. This information has been compiled in the descending order of R&D expenditure incurred in respect of some of the major industry groups for the year 1988-89 as delineated in Table 3.3.

Table 3.3
PUBLIC SECTOR INVESTMENT ON R&D BY MAJOR INDUSTRY GROUP DURING 1988-89

Sl. No.	Industry Group	No.of units	R&D Expenditure (Rs.lakhs)
1.	Defence	8	12970.30
2.	Electronics & Electricals Equipment	21	6225.01
3.	Metallurgical Industries	24	5229.45
4.	Telecommunications	12	3717.15
5.	Fuels	5	1873.71
6.	Chemicals(other than fertilizers)	6	1327.99
7.	Fertilizers	6	1142.17
8.	Miscellaneous Industries	2	1046.67
9.	Machine Tools	3	606.73
10.	Drugs & Pharmaceuticals	6	422.96
11.	Other Groups	28	1569.42
	Total	121	36131.56

INDUSTRY GROUPWISE CHANGE IN SHARES OF R&D EXPENDITURE IN PUBLIC SECTOR FROM 1986-87 TO 1988-89



It may be interesting to note from Table 3.3 that R&D expenditure was shared mainly by a few industry groups in the public sector. About 95.7% of total public sector R&D expenditure was by a little more than three fourth of the total public sector R&D units falling under ten major industry groups during 1988-89. About 24% of public sector R&D units under Defence and Electricals and Electronics industry groups have spent more than 50% of total R&D expenditure. About 6.6% of the industries under Defence group have spent about 35.9% of the total R&D expenditure during 1988-89. It may be appropriate to conclude from this that the R&D efforts of public sector industries more or less concentrated in a few areas.

Public sector R&D expenditure has been arranged by a few leading Ministries/Departments for the years 1986-87, 1987-88 and 1988-89 and the same is presented in Table 3.4.

Table 3.4
MINISTRY/DEPARTMENT-WISE R&D EXPENDITURE

Sl. No.	Name of Ministry/Department	R&D Expenditure(Rs.lakhs)		
		1986-87	1987-88	1988-89
1.	Defence Production & Supplies	6103.62	8391.58	12970.30
2.	Public Enterprises	5954.23	6046.95	6221.20
3.	Steel	2714.26	2970.74	3187.82
4.	Petroleum & Natural Gas	2138.53	2468.11	3151.58
5.	Telecommunications	2730.66	3236.68	3135.03
6.	Coal	373.06	1326.40	1599.53
7.	Petrochemicals	926.36	1177.89	1263.13
8.	Fertilizers	693.97	735.61	880.70
9	Other Ministries/Departments	935.06	1295.64	1972.72
10.	State Government Public Sector Industries	1000.14	1196.95	1749.55
	Total	23569.89	28846.55	36131.56

It might be seen from Table 3.4 that during the three years period R&D expenditure was shared mainly by a few Ministries/ Departments in the public sector. About 89.7% of the total public sector R&D expenditure was shared by Public sector industries under eight Ministries/Departments viz., Defence Production and Supplies, Public Enterprises, Steel, Petroleum and Natural gas, Telecommunications, Coal, Petrochemicals and Fertilizers during the year 1988-89. About 35.9% of the total expenditure on R&D activities was by the industries under the Department of Defence Production and Supplies. This was followed by Department of Public Enterprises which accounted for 17.2% of the total R&D Expenditure. Department of Steel, Petroleum and Natural Gas, Telecommunications, Coal, Petrochemicals and Fertilizers have a share of 8.8%, 8.7%, 8.7% ,4.4%,3.5% and 2.4% respectively. It may be mentioned here that the share of State Public Sector/joint sector industries was only 4.8% of the total public sector R&D expenditure during 1988-89.

It may also be seen from Table 3.4 that in case of public sector industries under department of Defence Production and Supplies, Coal and other ministries/departments, the percentage share of R&D expenditure in total R&D expenditure was showing an increasing trend during 1986-87 and 1988-89. However, in case of other Ministries either it was same or was showing a decreasing trend. The percentage share of State Public Sector/joint sector industries in total public sector R&D expenditure has also gone up during 1986-87 to 1988-89.

An attempt has been made to apportion R&D expenditure of public sector R&D units between different objectives prescribed by UNESCO. Ideally this exercise ought to be done on project to project basis, but due to *operational problems, it has not been possible to do so Therefore, each* industry has been assigned to a particular objective based on its predominant activity. On this basis, the R&D expenditure for a few major aims in descending order for the year 1988-89 is given in Table 3.5.

Table 3.5
DISTRIBUTION OF R&D EXPENDITURE BY MAJOR AIMS DURING 1988-89

Aims	R&D expenditure (Rs.crores)
Promotion of Industrial Development	158.24
Defence	129.70
Development of Transport & Communication	37.97
Production,Conservation & Distribution of Energy	24.55
Development of Agriculture, Forestry & Fishing	6.41
Development of Health Services	4.44
Total	361.31

It may be noted from Table 3.5 that 97% of total public sector R&D expenditure was accounted for by the aims-Promotion of Industrial development, Defence, Development of Transportation and Communication and Production conservation and distribution of energy in that order. The aim development of health services received a mere 1.2% of total public sector R&D expenditure. More than three fourth (79.7%) of total public sector R&D expenditure was on the aim promotion of Industrial development and Defence.

An attempt has also been made to classify the total R&D expenditure of public sector units into different fields of science. During 1988-89, about 76.6% of the total R&D expenditure was in the field Engineering/ Technology, about 21.3% in Natural Science, about 1.2% in Medical Science and rest 0.9% in Agricultural Science. The table given at the end provides this information for the years 1986-87, 1987-88 and 1988-89 may also be seen in this context.

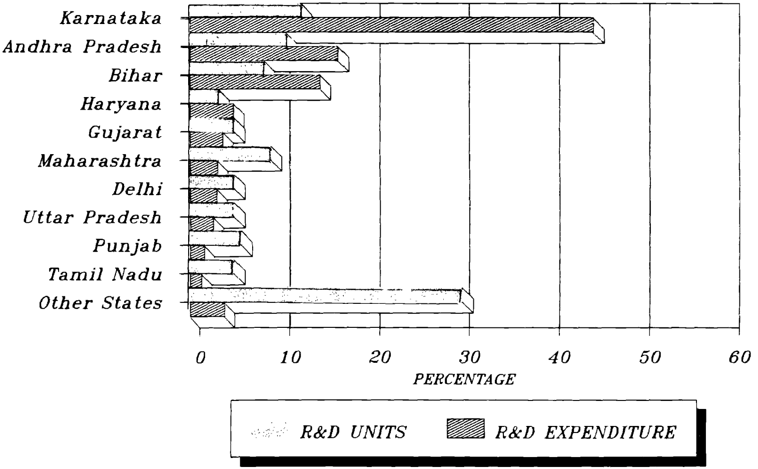
Out of the total public sector R&D expenditure of Rs.361.31 crores, the break up into revenue and capital expenditure was available for Rs. 343.47 crores during the year 1988-89. Out of this, 73.7% was accounted for by revenue expenditure and rest 26.3% was accounted for by capital expenditure. The revenue expenditure has increased from Rs.160.24 crores in 1986-87 to Rs. 198.55 crores in 1987-88 and to Rs.253.29 crores in 1988-89. The growth of revenue expenditure of 1988-89 over the previous year was about 27.6% whereas, capital expenditure has increased from Rs.74.41 crores in 1986-87 to Rs.88.82 crores in 1987-88 and to Rs.90.19 crores in 1988-89 representing an increase of about 19.3% and 1.5% respectively.

A breakup has been attempted in respect of State -wise expenditure on research and development by the public sector industries of both Central and State Governments. The information was computed on the basis of location of R&D centres and the same has been presented in Table 3.6 in descending order of R&D expenditure during 1988-89.

Table 3.6
STATE-WISE INVESTMENT ON R&D BY PUBLIC SECTOR INDUSTRIES DURING 1988-89

Sl. No.	State	R&D Units		R&D Expenditure	
		No.	Percentage	(Rs.lakhs)	Percentage
1	Karnataka	15	12.4	16222.76	44.9
2.	Andhra Pradesh	13	10.7	5962.62	16.5
3.	Bihar	10	8.3	5223.21	14.5
4.	Haryana	4	3.3	1752.56	4.9
5.	Gujarat	6	5.0	1323.14	3.7
6.	Maharashtra	11	9.1	1116.98	3.1
7.	Delhi	6	5.0	1101.44	3.0
8.	Uttar Pradesh	6	5.0	957.49	2.6
9.	Punjab	7	5.8	568.18	1.6
10.	Tamil Nadu	6	5.0	478.11	1.3
11.	Other States	37	30.4	1425.06	3.9
	Total	121	100.0	36131.55	100.0

STATEWISE SHARE OF PUBLIC SECTOR R&D UNITS/R&D EXPENDITURE DURING 1988-89



It may be interesting to note from Table 3.6 that about 48.8% of total R&D units which were located in the States of Karnataka, Andhra Pradesh, Bihar, Haryana, Gujarat and Maharashtra accounted for about 87.5% of total public sector R&D expenditure during 1988-89. Out of this, about 12.4% of R&D units which account for about 44.9% of the total R&D expenditure were located in the State of Karnataka alone. This was followed by Andhra Pradesh, Bihar, Haryana,Gujarat and Maharashtra with 10.7%, 8.3%, 3.3%, 5.0% and 9.1% of total R&D units accounting for about 16.5%, 14.4%, 4.8%, 3.7% and 3.1% of total public sector R&D expenditure respectively. It may also be interesting to note from this table that per unit R&D expenditure for units located in the States of Karnataka, Andhra Pradesh, Bihar and Haryana was more than the overall per unit R&D expenditure during 1988-89. The per unit R&D expenditure for these States was also more as compared to other states. It appears from this that concentration of R&D in public sector lies with the above mentioned four States. It may not be out of place to mention here that while interpreting the above results it has to be borne in mind that some of the public sector industries have more than one R&D centre located in more than one State. As the data were not available for all such centres separately the entire expenditure has been shown against only one State.

In order to study the changes in the pattern of R&D expenditure, an attempt has been made to classify the percentage of total R&D units and their share in total R&D expenditure between different sizes of R&D expenditure during the years 1986-87, 1987-88 and 1988-89. The total number of R&D units have been kept constant for all the three years so that the increase or decrease in R&D expenditure could be studied meaningfully.

Table 3.7

PATTERN OF R&D EXPENDITURE IN PUBLIC SECTOR FROM 1986-87 TO 1988-89

R&D Expenditure (Rs.lakhs)	1986-87		1987-88		1988-89	
	% of R&D Units	R&D Exp. (Rs.Lakhs)	% of R&D units	R&D Exp. (Rs.Lakhs)	% of R&D units	R&D Exp. (Rs.lakhs)
Less than 10	28.1	123.82	29.8	161.18	23.1	99.97
10-30	22.3	482.11	24.8	611.27	16.5	376.76
30-100	25.6	1816.75	16.5	1223.98	24.0	1514.46
100-200	6.6	1367.94	9.1	1432.61	14.9	2243.04
200-300	5.8	1694.69	4.9	1580.49	4.1	1176.54
300-400	3.3	1366.78	3.3	1371.45	2.5	1065.99
400 & Above	8.3	16717.80	11.6	22465.57	14.9	29654.79
Total	100.0	23569.89	100.0	28846.55	100.0	36131.55

A glance at the figures of Table 3.7 shows that the percentage of R&D units spending Rs.100 lakhs or less per unit on R&D, has declined from 76% in 1986-87 to 71.1% 1987-88 and to 63.6% in 1988-89. The public sector R&D units spending between Rs.100 lakhs and Rs. 200 lakhs per unit showed a clear upward trend in terms of their share both in total R&D expenditure and the number of R&D units. The units spending between Rs.200 lakhs to Rs.400 lakhs each was showing a downward trend both in their total R&D expenditure and in the number of units. The public sector industries spending more than Rs.400 lakhs per unit showed an upward trend for their share in total R&D expenditure and number of units from 1986-87 to 1988-89. The analysis indicates that more public sector industrial units tend to join the groups of higher per unit R&D expenditure during the year 1988-89.

As mentioned elsewhere in the report, an attempt has been made to classify the various industrial groups into three categories based on their R&D intensity which has been measured on the basis of two indices (i) R&D expenditure as percentage of sales turnover (ii) the number of R&D personnel per thousand employees. The industrial groups which devote comparatively higher percentage of their sales turnover and deploy more R&D personnel per thousand employees were most R&D intensive and these industry groups were placed in category-I. The industry groups with comparatively lower figures for both of the indices were placed in category-III. The rest of the industry groups were placed in category-II or medium R&D intensive. On this basis, category-I consists of 8 industry groups, category II & category III consist of 9 industry groups each. Table 3.8 gives category-wise information based on the two R&D intensity indices.

Table 3.8
R&D INTENSITY IN PUBLIC SECTOR, 1988-89

Sl. No.	Industry Group	R&D Expenditure as % of Sales turnover	R&D Personnel per thousand employees
CATEGORY- I			
1.	Defence Industries	8.60	58
2.	Glass	6.04	13
3.	Machine Tools	2.68	42
4	Math, Surveying & Drawing Instruments	2.47	20
5.	Electricals & Electronics	1.55	15
6.	Drugs & Pharmaceuticals	1.53	17
7.	Telecommunications	0.93	49
8.	Chemicals (other than Fertilizers)	0.96	21
CATEGORY-II			
1.	Miscellaneous Mech. Engg.Industries	26.32*	2
2.	Miscellaneous Industries	4.31	7
3.	Industrial Equipment	2.21	7
4.	Textiles	1.01	10
5.	Industrial Machinery	1.01	7
6.	Photographic Raw Films & Paper	0.70	39
7.	Agricultural Machinery	0.62	17
8.	Transportation	0.45	39
9.	Fertilizers	0.40	15
CATEGORY-III			
1.	Paper & Pulp	0.54	3
2.	Ceramics	0.47	4
3.	Cement and Gypsum Products	0.45	3
4.	Metallurgical Industries	0.43	5
5.	Rubber Goods	0.39	15
6.	Boilers & Steam Generating Plants	0.15	5
7.	Fuels	0.11	7
8.	Soaps, Cosmetics & Toilet Preparations	0.11	7
9.	Food Processing Industries	0.09	3

* Only one industry in this group with high capital R&D expenditure.

It may be seen from Table 3.8 that to a large extent indices are consistent between the different categories with some exceptions. To give a few examples of inconsistency, the R&D manpower index for industry groups Transportation, Photographic Raw Film and Paper, Agricultural Machinery, Fertilizers which were put in category-II was comparable to some of the industry groups in Category-I. The R&D expenditure index of Miscellaneous Industries, Industrial Equipment, Textile and Industrial Machinery industry group was comparable to some of the industry groups in category-I. Similarly, the R&D manpower index for industry group Rubber Goods, Fuels and Soaps, Cosmetics and Toilets Preparations put in category-III was comparable to some of the industry groups of category-II Miscellaneous Mechanical Engineering Industries group shows a high R&D expenditure index with low R&D manpower index when compared in all categories and this may be due to the fact that only one industry was under this group and its capital expenditure was quite high and the sales turnover figure is also quite low.

Table 3.9 gives information on the total number of employees of the company in different ranges, the percentage of total number of R&D units and average per unit R&D expenditure in these ranges during 1988-89.

Table 3.9
CLASSIFICATION OF PUBLIC SECTOR R&D UNITS BY TOTAL EMPLOYMENT SIZE

Total Employment size	Percentage of R&D units	Average Per Unit R&D expenditure 1988-89 (Rs.lakhs)
1-200	11.6	39.8
201-500	9.9	71.2
501-1500	20.7	161.6
1501-3000	15.7	357.4
3001-5000	15.7	295.8
More than 5000	25.6	541.9
Not available	0.8	1471.0
Overall	100.0	298.6

It may be seen from Table 3.9 that more than one fourth of the total public sector industries were having total employees more than 5000 and only 11.6% of the total R&D units were having 200 or less employees. This information was not available for 0.8% of total industrial R&D units. It may also be seen from this table that to a large extent the average per unit R&D expenditure was showing a consistent increase with the increase of total employment size of the industries with some exceptions.

Table 3.10 gives the information on the total number of R&D personnel in different ranges of employment, percentage of total number of R&D units and average per unit R&D expenditure in these ranges.

Table 3.10
CLASSIFICATION OF PUBLIC SECTOR R&D UNITS BY R&D EMPLOYMENT SIZE

R&D Employment size	Percentage of R&D units	Average per unit R&D expenditure 1988-89 (Rs.lakhs)
1-40	63.6	72.6
41-80	13.2	114.2
81-120	5.0	410.6
121-160	2.5	145.7
161-200	1.6	329.3
More than 200	13.2	1572.3
Not available	0.8	0.5
Overall	100.0	298.6

It may be noted from Table 3.10 that 63.6% of total industries in public sector have employed 1-40 R&D personnel. Only about 14.8% of total R&D units have employed 161 or more employees on R&D. It may also be observed from this table that with the increase in the R&D employment size there was a corresponding increase in the average per unit R&D expenditure except in the range of 81-120 where average per unit R&D expenditure was much higher

One other major indicator to point out the extent of country's R&D effort is the quantum of manpower deployed in R&D institutions. As on 1st April, 1988, about 2.68 lakh S&T personnel were employed in all R&D organisations in the country. Out of this about 0.28 lakh were working in 121 public sector/joint sector industries. The personnel employed in R&D establishments of public sector were either engaged in research work or auxiliary activities or providing administrative support for research activities. This was comprised of full time personnel and full time equivalent of those employed on part time basis. The percentage breakup of these personnel into the above three categories namely R&D,

auxiliary and administrative activities in public sector R&D units was 45.8%, 35.3% and 18.9% respectively. The share of public sector personnel employed in the R&D units in total at national level was 10.3%.

Table 3.11 gives information on the percentage distribution of R&D personnel by qualifications in different fields.

Table 3.11
PERCENTAGE DISTRIBUTION OF R&D PERSONNEL BY QUALIFICATIONS IN DIFFERENT DISCIPLINES

		Qualifications			
Sl. No.	Field	Ph.D	Post Graduate	Graduate	Diploma & Others
1.	Natural Sciences	58.4	25.7	14.7	8.6
2.	Agricultural Sciences	2.2	0.5	0.2	0.1
3.	Engineering	38.5	73.3	84.2	90.5
4.	Medical Sciences	0.9	0.2	0.1	-
5.	Social Sciences	-	0.3	0.8	0.8
	Total	100.0 (680)	100.0 (2089)	100.0 (4230)	100.0 (5598)

It may be noted from Table 3.11 that 58.4% of total Ph.Ds employed in R&D departments of the public sector/joint sector had Natural Sciences as their discipline next to this comes Engineering which had 38.5% of the total Ph.Ds and rest 3.1% had Ph.D in Agriculture and Medical Sciences. In case of post graduate, graduate and diploma and others category, Engineering field dominated over all other disciplines followed by Natural Sciences. It might be inferred from this that majority of R&D personnel working in public sector industries had either qualifications in Engineering or Natural Sciences.

Table 3.12 gives information on the percentage distribution of R&D personnel by fields of specialisation with different qualifications in R&D departments of the public sector/joint sector companies.

DISTRIBUTION OF R&D PERSONNEL BY QUALIFICATIONS IN PUBLIC SECTOR AS ON APRIL 1,1988

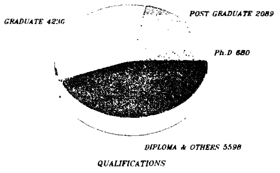


Table 3.12
PERCENTAGE DISTRIBUTION OF R&D PERSONNEL BY FIELD OF SPECIALISATION WITH DIFFERENT QUALIFICATION

Sl. No.	Qualification	Disciplines				
		Natural Sciences	Agricultural Sciences	Engg.	Medical Sciences	Social Sciences
1.	Ph.D	19.5	44.1	2.5	42.9	7.9
2.	Post Graduate	26.3	26.5	14.7	35.7	41.6
3.	Graduate	23.7	8.8	48.6	-	50.5
4.	Diploma & Others	23.7	8.8	48.6	-	50.5
	Total	100.0 (2035)	100.0 (34)	100.0 (10425)	100.0 (14)	100.0 (89)

It may be interesting to note from Table 3.12 that 45.8% of total R&D personnel in Natural Sciences were having Post Graduate or above qualifications, in case of Agriculture Sciences, 70.6% were having Post graduate or above qualifications and in case of Medical Sciences 78.6% were having Post Graduate or above qualifications, whereas in case of Engineering, and Social Sciences, R&D personnel with graduate, diploma and others qualifications were dominating.

Out of 12652 persons employed on R&D work, disciplines and qualifications were known for 12597 persons. About 82.7% of this had Engineering as their background. Natural Sciences accounted for 16.2% of the total R&D personnel. Agricultural Sciences, Social Sciences and Medical Sciences account for 1.1% of total R&D personnel in public sector. About 5.4% of total R&D personnel employed in public sector were having Ph.D degree, 16.6% were having post graduate degree, 33.6% were having graduate degree and rest 44.4% were having diploma or other qualifications.

Table 3.13 gives percentage breakup of total R&D personnel employed in public sector R&D units by major industry group.

Table 3.13
PERCENTAGE DISTRIBUTION OF R&D PERSONNEL BY MAJOR INDUSTRY GROUPS

Sl. No.	Industry Group	Percentage of total R&D personnel
1.	Defence	27.1
2.	Telecommunications	18.7
3.	Metallurgical Industries	15.4
4.	Electricals & Electronics	13.8
5.	Machine Tools	5.6
6.	Transportation	4.4
7.	Fertilizers	2.9
8.	Drugs & Pharmaceuticals	2.7
9.	Chemicals	2.5
10.	Fuels	1.8
11.	Other Groups	5.1
	Total	100.0

It may be interesting to note that 94.9% of total R&D personnel were employed in ten major industry groups. About three-fourth of total R&D personnel were employed in the first four industry groups shown in Table 3.13. It may be appropriate to infer from Table 3.13 that R&D personnel employed in public sector R&D units were concentrated in a few industry groups.

Out of 12,652 R&D personnel employed in the public sector information about salary scales were available for 11,902 i.e. about 94%. The relevant table containing data on salary scales in respect of public sector is given at the end and this may be referred while going through the next paragraph.

As mentioned elsewhere in the report that there are no well defined salary scales in the private sector and in order to compare public and private sector, industries were approached to provide this information in the salary scales provided by the department. The scales were made uniform by keeping a difference of Rs.1000 between each scale. However, in some cases it is seen that information provided by public sector indicates total emoluments rather than salary scale. Therefore, the data provided at the end may be used with caution. Some of the interesting points emerging out of the analyses are that almost half of the R&D personnel employed in the public sector were in the scale between Rs. 1000 to Rs. 2000 and moreover 12.5% of total R&D personnel in public sector were in the scales less than Rs.1000.

About 17999 female personnel were employed in R&D establishments in the country. Out of this 1086 were employed in the public sector. About 592 female personnel were engaged directly on

R&D activities in public sector inhouse R&D units. Out of 100 female personnel employed in public sector industries, 54.5 were engaged directly on R&D activities, 17.8 were performing auxiliary activities and 27.7 were providing administrative support. It may be seen from the table given at the end that for every 1000 R&D employees in public sector, 47 were female R&D employees.

More than three-fourth of total female R&D personnel employed in the public sector had Engineering discipline.This was followed by Natural Sciences with 22.6%. of 592 female R&D personnel employed in public sector for whom qualifications were known, only 20.0% were having post graduate or above qualifications, 43.7% were graduates and 36.3% were having diploma or other qualifications.

To sum up, the salient features are as follows:

- Public sector R&D expenditure attained a level of Rs.361.32 crores at current prices in 1988-89 which was 25.2% more than the R&D expenditure of previous year.
- The ratio of R&D expenditure to sales turnover was estimated at 0.77% in 1988-89 .
- A little less than one-fourth of total public sector R&D units under Defence and Electricals and Electronics Industry group have spent more than fifty per cent (53.1%) of total R&D expenditure.
- About 89.7% of the total public sector R&D expenditure was shared by public sector industries under eight Ministries/Departments viz., Defence Production and Supplies, Public Enterprises, Steel, Petroleum and Natural Gas, Telecommunications, Coal, Petrochemicals and Fertilizers during the year 1988-89.
- More than three-fourth (79.7%) of total public sector R&D expenditure was utilised for the aim of promotion of industrial development and Defence.
- About 48.8% of total public sector R&D units located in the States of Karnataka, Andhra Pradesh, Bihar, Haryana, Gujarat and Maharashtra accounted for about 87.5% of total public sector R&D expenditure during 1988-89.
- As on 1st April, 1988, 27611 personnel were employed in Public sector R&D units. Out of this 45.8% were engaged on R&D, 35.3% were employed on auxiliary activities and 18.9% were providing administrative support.
- Out of every 1000 R&D employees in public sector, 47 were female R&D employees.
- 5.4% of total R&D personnel employed in public sector had Ph.D qualifications, 16.6% had post graduate qualifications, 33.6% had graduate qualifications and the rest 44.4% had diploma and other qualifications.
- 82.7% of the R&D personnel in public sector had Engineering as their field of specialisation.
- About three-fourth of total R&D personnel were employed in Defence, Telecommunications, Metallurgical Industries and Electricals and Electronics industry groups.
- Almost half of the R&D personnel employed in the public sector were in the pay scales between Rs. 1000 to Rs. 2000.

TABLES

Table 1
R&D EXPENDITURE BY PUBLIC, PRIVATE AND INDUSTRIAL SECTORS FROM 1980-81 TO 1989-90

(Rs.Lakhs)

		Public Sector			Private Sector			Industrial Sector		
Sl. No.	Year	No.of Units	R&D Expenditure		No.of Units	R&D Expenditure		No.of Units	R&D Expenditure	
			Current Prices	Constant Prices (1980-81)		Current Prices	Constant Prices (1980-81)		Current Prices	Constant Prices (1980-81)
1.	1980-81	68	8636.50	8636.50	600	12069.10	12069.10	668	20705.60	20705.60
2.	1981-82	-do-	10755.30	9756.12	-do-	14700.00	13334.36	-do-	25455.30	23090.48
3.	1982-83	80	12246.30	10283.08	816	19698.12	16540.28	896	31944.42	26823.36
4.	1983-84	-do-	16165.50	12519.05	-do-	20782.81	16094.83	-do-	36948.31	28613.88
5.	1984-85	95	17122.09	12340.23	865	23319.40	16806.75	960	40441.49	29146.98
6.	1985-86	-do-	19861.75	13325.97	-do-	25194.40	16903.83	-do-	45056.15	30229.80
7.	1986-87	121	23569.89	14780.38	895	29163.28	18287.92	1016	52733.17	33068.30
8.	1987-88	-do-	28846.55	16646.02	-do-	31026.65	17904.05	-do-	59873.20	34550.07
9.	1988-89	-do-	36131.56	19422.71	-do-	36378.58	19555.49	-do-	72510.14	38978.20
10.	1989-90		41551.29			43654.30			85205.59	

Source: Data Collected & Compiled by DST

Note
1) Data from 1980-81 to 1988-89 compiled on the basis of returns furnished by responding units
2) Data for 1989-90 has been projected by applying following rates of growth: Public Sector 15%,Private Sector 20%
3) For working out R&D expenditure at constant prices, GNP Price deflator as per Economic Survey 1988-89 have been used.

Table 2
INDUSTRIAL R&D EXPENDITURE ON ADVERTISING, NEW PLANT AND EQUIPMENT VERSUS SALES TURNOVER

	R&D Expenditure (Rs. Crores)		Advertising Expenditure (Rs. Crores)		Expenditure on New Plant & Equipment (Rs. Crores)		Sales Turnover (Rs. Crores)		R&D Expenditure as % of Sales Turnover		Advertising Expenditure as % of Sales Turnover		New Plant & Equipment Expenditure as % of Sales Turnover	
Year	Public Sector	Private Sector	Public Sector	Private Sector	Public Sector	Private Sector	Public Sector	Private Sector	Public Sector	Private Sector	Public Sector	Private Sector	Public Sector	Private Sector
1986-87	219.71	269.80	22.29	227.73	1834.63	2216.67	37506.12	41863.75	0.59	0.64	0.06	0.54	4.89	5.29
1987-88	268.50	287.04	26.34	268.87	2292.59	2925.18	42374.11	49838.68	0.68	0.58	0.06	0.54	5.41	5.87
1988-89	325.39	336.55	28.26	286.40	1355.07	1595.04	47166.42	54208.36	0.70	0.62	0.06	0.53	2.87	2.94

Source : Data collected & compiled by DST.

Table 3
GROWTH OF INDUSTRIAL R&D UNITS IN THE PUBLIC, PRIVATE AND INDUSTRIAL SECTORS

Sl. No.	Period	Public Sector	Private Sector	Industrial Sector
1.	Pre-Independence	2	9	11
2.	August, 1947 to 1960-61	8	35	43
3.	Third Five Year Plan(1961-62 to 1965-66)	6	53	59
4.	Annual Plans(1966-67 to 1968-69)	5	40	45
5.	Fourth Five Year Plan(1969-70 to 1973-74)	23	162	185
6.	Fifth Five Year Plan(1974-75 to 1978-79)	27	189	216
7.	1979-80 to 1983-84	39	215	254
8.	1984-85 to 1988-89	11	96	107
	Total	121	799	920

Source: Data collected & compiled by DST.

Table 4
REVENUE,CAPITAL AND TOTAL EXPENDITURE ON R&D BY PUBLIC & PRIVATE SECTORS FROM 1986-87 TO 1988-89

(Rs.Lakhs)

		Public Sector R&D Expenditure			Private Sector R&D Expenditure		
		1986-87	1987-88	1988-89	1986-87	1987-88	1988-89
1.	Revenue	16024.50	19854.72	25328.60	18715.19	19935.57	22266.34
2.	Capital	7441.22	8881.70	9019.14	7485.24	7661.95	10413.98
3.	Not Classified	104.17	110.13	1783.81	779.67	1106.40	974.92
	Total	23569.89	28846.55	36131.55	26980.10	28703.92	33655.24

Source: Data collected & compiled by DST

Table 5
R&D EXPENDITURE BY FIELD OF SCIENCE

(Rs.Lakhs)

Sl. No.	Field Name	Number of Industries	Public Sector R&D Expenditure			Number of Industries	Private Sector R&D Expenditure		
			1986-87	1987-88	1988-89		1986-87	1987-88	1988-89
1.	Natural Sciences	34	5717.66	6624.97	7683.52	265	7001.15	7342.19	8808.08
2.	Engineering & Technology	77	17184.17	21512.14	27678.16	463	14805.49	15585.85	18497.04
3.	Medical Sciences	7	428.75	392.12	430.77	82	4302.52	4829.48	5326.80
4.	Agricultural Sciences	3	239.31	317.32	339.10	18	870.95	946.40	1023.34
5.	Social Sciences	0	0.00	0.00	0.00	0	0.00	0.00	0.00
	Total	121	23569.89	28846.55	36131.55	828	26980.11	28703.92	33655.26

Table 6
R&D EXPENDITURE BY OBJECTIVES

(Rs.Lakhs)

Sl. No.	Objective	Number of industries	Public Sector R&D Expenditure			Number of Industries	Private Sector R&D Expenditure		
			1986-87	1987-88	1988-89		1986-87	1987-88	1988-89
1.	Exploration and Assessment of Earth, Seas, Atmosphere	0	0.00	0.00	0.00	0	0.00	0.00	0.00
2.	Space	0	0.00	0.00	0.00	0	0.00	0.00	0.00
3.	Development of Agriculture, Forestry & Fishing	8	490.56	585.35	640.92	34	1450.73	1530.24	1768.06
4.	Promotion of Industrial Development	70	11300.00	13768.57	15824.24	551	14543.15	15242.93	18511.11
5.	Production,Conservation & Distribution of Energy	11	1779.14	1891.36	2454.76	76	3661.38	4173.55	4448.39
6.	Development of Transport & Communication	16	3466.20	3815.93	3796.91	75	2858.93	2781.88	3442.65
7.	Development of Education Services	0	0.00	0.00	0.00	0	0.00	0.00	0.00
8.	Development of Health Services	8	430.37	393.76	444.42	83	4296.96	4813.22	5289.62
9.	Social Development & Other Socio-Economic Services	0	0.00	0.00	0.00	1	5.19	5.43	5.71
10.	Protection of Environment	0	0.00	0.00	0.00	2	27.35	36.38	17.52
11.	General Advancement of Knowledge	0	0.00	0.00	0.00	3	54.82	20.46	57.40
12.	Other Aims	0	0.00	0.00	0.00	3	81.60	99.83	114.80
13.	Defence	8	6103.62	8391.58	12970.30	0	0.00	0.00	0.00
	Total	121	23569.89	28846.55	36131.55	828	26980.11	28703.92	33655.26

Source: Data collected & compiled by DST

Table 7
CLASSIFICATION OF PRIVATE SECTOR R&D EXPENDITURE BY R&D EMPLOYMENT SIZE

(Rs.Lakhs)

Sl. No.	Employment Size	No. of Units	R&D Expenditure		
			1986-87	1987-88	1988-89
1	1-5	163	853.11	1007.15	1253.51
2	6-10	229	2712.86	2787.39	3484.66
3	11-15	124	2240.93	2096.67	2700.08
4	16-20	79	1513.98	1721.18	2121.43
5	21-25	65	2797.13	2327.61	2325.88
6	26-30	38	1259.95	1473.59	1550.18
7	31-35	25	1334.27	1617.10	1934.82
8	36-40	7	418.86	454.73	615.25
9	41-45	8	895.71	1027.48	1355.50
10	46-50	9	507.85	714.57	977.28
11	51-55	10	473.77	512.27	656.90
12	56-60	8	760.14	858.50	980.81
13	61-65	5	262.14	339.02	542.98
14	66-70	4	507.23	471.58	549.78
15	71-75	5	790.49	824.68	1389.84
16	76-80	6	579.10	644.18	758.38
17	81-85	2	568.45	340.27	342.04
18	86-90	0	0.00	0.00	0.00
19	91-95	2	595.14	796.40	817.73
20	96-100	5	1301.83	1688.07	1799.60
21	101-120	7	839.24	940.76	945.63
22	121-140	6	1417.56	1310.17	1415.34
23	141-160	4	1004.36	1096.01	1368.76
24	161-180	5	791.04	969.28	1179.60
25	181-200	2	207.36	192.55	258.78
26	More than 200	5	2337.91	2485.76	2320.33
27	Not available	5	9.70	6.95	10.17
	Total	828	26980.11	28703.92	33655.26

Source: Data collected & compiled by DST.

Table 8
CLASSIFICATION OF PRIVATE SECTOR R&D EXPENDITURE BY TOTAL EMPLOYMENT SIZE

Sl. No	Employment Size (Total)	No. of Units	R&D Expenditure		
			1986-87	1987-88	1988-89
1	1-10	12	52.38	88.80	68.12
2	11-20	28	219.32	249.21	246.15
3	21-30	10	76.99	101.42	68.33
4	31-40	26	126.51	140.47	171.95
5	41-50	14	288.22	384.67	310.73
6	51-60	11	27.76	61.94	78.66
7	61-70	16	257.14	320.22	380.82
8	71-80	22	237.21	257.05	412.96
9	81-90	13	588.89	505.84	480.60
10	91-100	15	185.63	187.30	360.91
11	101-150	50	342.47	469.80	673.21
12	151-200	38	524.81	582.04	721.54
13	201-250	40	560.33	619.13	657.46
14	251-300	36	316.11	376.79	517.76
15	301-350	31	349.65	444.84	681.24
16	351-400	29	393.54	382.10	557.38
17	401-450	16	231.55	263.11	317.12
18	451-500	31	588.45	523.22	539.03
19	501-750	87	3175.67	2245.39	2710.11
20	751-1000	50	1110.88	1291.20	1523.30
21	1001-1500	69	2561.61	2948.95	3384.31
22	1501-2000	36	1461.89	1914.11	2318.07
23	2001-3000	54	2388.40	2842.04	3252.68
24	3001-4000	29	2143.03	2187.19	2417.22
25	4001-5000	19	1423.09	1200.68	1307.93
26	More than 5000	46	7348.58	8116.41	9497.67
27	Not available	0	0.00	0.00	0.00
	Total	828	26980.11	28703.92	33655.26

Source: Data collected & compiled by DST.

Table 9
CLASSIFICATION OF PRIVATE SECTOR R&D UNITS ON THE BASIS OF EXPENDITURE INCURRED ON R&D DURING 1988-89

Sl. No.	Range of Expenditure per unit		Number of units	R&D Expenditure (Rs.Lakhs)
1	0-10	....	362	1491.40
2	10-20	....	166	2344.44
3	20-30	....	66	1670.28
4	30-50	....	71	2813.48
5	50-100	....	83	5865.32
6	100-200	....	43	6105.72
7	200-300	....	17	3929.30
8	300-400	....	6	1977.89
9	400-500	....	6	2673.80
10	More than 500	....	8	4783.63
Total		....	828	33655.26

Source: Data collected & compiled by DST.

Table 10
CLASSIFICATION OF PUBLIC SECTOR R&D EXPENDITURE BY R&D EMPLOYMENT SIZE

(Rs.Lakhs)

Sl. No.	Employment Size R&D	No. of Units	R&D Expenditure		
			1986-87	1987-88	1988-89
1	1-5	15	80.21	98.90	149.23
2	6-10	17	539.44	370.11	607.19
3	11-15	8	121.83	144.79	287.78
4	16-20	12	343.36	274.69	598.84
5	21-25	11	583.97	742.25	804.42
6	26-30	6	317.27	352.44	528.29
7	31-35	4	452.27	1053.51	1463.84
8	36-40	4	671.67	1081.93	1148.33
9	41-45	3	88.17	132.98	167.25
10	46-50	2	131.90	148.00	221.37
11	51-55	3	325.37	438.79	572.85
12	56-60	2	73.22	113.11	129.70
13	61-65	1	93.94	104.20	117.19
14	66-70	2	201.28	243.86	236.10
15	71-75	1	40.81	44.04	105.46
16	76-80	2	29.70	39.16	277.59
17	81-85	1	75.17	54.82	51.00
18	86-90	1	14.57	31.10	32.79
19	91-95	0	0.00	0.00	0.00
20	96-100	1	994.27	1076.12	1471.00
21	101-120	3	623.08	898.02	908.53
22	121-140	2	98.44	311.60	112.03
23	141-160	1	199.88	259.89	325.00
24	161-180	1	210.91	280.12	439.06
25	181-200	1	213.90	205.89	219.53
26	More than 200	16	17036.65	20340.51	25156.68
27	Not available	1	8.61	5.72	0.50
	Total	121	23569.89	28846.55	36131.56

Source: Data collected & compiled by DST.

Table 11
CLASSIFICATION OF PUBLIC SECTOR R&D EXPENDITURE BY TOTAL EMPLOYMENT SIZE

(Rs.Lakhs)

Sl. No.	Employment Size (Total)	No.of Units	R&D Expenditure		
			1986-87	1987-88	1988-89
1	1-10	0	0.00	0.00	0.00
2	11-20	0	0.00	0.00	0.00
3	21-30	0	0.00	0.00	0.00
4	31-40	0	0.00	0.00	0.00
5	41-50	2	28.90	29.81	37.39
6	51-60	1	37.69	29.71	33.01
7	61-70	3	34.87	49.20	58.19
8	71-80	0	0.00	0.00	0.00
9	81-90	0	0.00	0.00	0.00
10	91-100	0	0.00	0.00	0.00
11	101-150	7	98.18	123.33	427.63
12	151-200	1	0.68	22.16	1.20
13	201-250	3	3.20	4.44	11.16
14	251-300	3	161.02	204.03	265.00
15	301-350	1	13.77	16.08	25.00
16	351-400	0	0.00	0.00	0.00
17	401-450	2	18.85	10.94	12.81
18	451-500	3	221.95	357.84	540.60
19	501-750	8	66.47	57.38	158.87
20	751-1000	6	342.84	702.74	790.31
21	1001-1500	11	2835.71	2787.59	3089.79
22	1501-2000	13	742.11	772.83	1207.67
23	2001-3000	6	3931.04	5114.70	5583.04
24	3001-4000	15	2170.01	3936.43	4820.66
25	4001-5000	4	838.94	903.59	798.96
26	MORE THAN 5000	31	11029.39	12647.63	16799.26
27	NOT AVAILABLE	1	994.27	1076.12	1471.00
	TOTAL	121	23569.89	28846.55	36131.56

Source: Data collected & compiled by DST.

Table 12
CLASSIFICATION OF PUBLIC SECTOR UNDERTAKINGS ON THE BASIS OF EXPENDITURE INCURRED DURING 1986-87 TO 1988-89

(Rs.Lakhs)

Sl. No.	Expenditure size	No. of Units			R&D Expenditure		
		1986-87	1987-88	1988-89	1986-87	1987-88	1988-89
1.	0-10	34	36	28	123.82	161.18	99.97
2.	10-20	18	14	12	260.09	205.92	182.97
3.	20-30	9	16	8	222.02	405.35	193.79
4.	30-50	12	7	16	447.27	269.91	583.77
5.	50-100	19	13	13	1369.48	954.07	930.69
6.	100-200	8	11	18	1367.94	1432.61	2243.04
7.	200-300	7	6	5	1694.69	1580.49	1176.54
8.	300-400	4	4	3	1366.78	1371.45	1065.99
9.	400-500	1	0	3	407.24	0.00	1361.13
10.	More than 500	9	14	15	16310.56	22465.57	28293.66
	Total	121	121	121	23569.89	28846.55	36131.55

Source: Data collected & compiled by DST.

Table 13
R&D EXPENDITURE BY PUBLIC/JOINT SECTOR UNDERTAKINGS, 1988-89

Ministry/ Department/State	Name of Undertaking	R&D Expenditure (Rs.Lakhs)	R&D Expenditure as % of STO
Atomic Energy	Electronics Corporation of India Ltd	581.68	2.93
	India Rare Earths Ltd	123.35	2.51
	Uranium Corporation of India Ltd	18.94	0.66
Electronics	CMC Ltd	439.06	4.28
	Electronics Trade & Technology Dev.Corp	2.81	0.03
Scientific & Industrial Research	Central Electronics Ltd	380.00	15.14
Fertilizers	Madras Fertilizers Ltd	31.16	0.10
	Rashtriya Chemicals & Fertilizers Ltd	109.97	0.10
	The Fertilizer & Chemicals Travancore Ltd	66.00	0.16
	Projects & Development India Ltd	673.57	24.28
Telecommunications	Indian Telephone Industries Ltd,Banglore	2472.00	3.36
	Indian Telephone Industries Ltd, Naini	512.00	5.70
	Videsh Sanchar Nigam Ltd	108.75	5.80
	Hidustan Teleprinters Ltd	42.28	2.02
Defence Production & Supplies	Bharat Electronics Ltd	5176.70	11.77
	Bharat Dynamics Ltd	15.00	0.25
	Hindustan Aeronautics Ltd, Bangalore	5199.82	13.40
	Hindustan Aeronautics Ltd, Kanpur	2.21	0.06
	Hindustan Aeronautics Ltd, Nasik	159.65	0.79
	Hindustan Aeronautics Ltd, Lucknow	512.94	8.07
	Hindustan Aeronautics Ltd,Hyderabad	844.67	18.52
	Bharat Earth Movers Ltd	1059.31	1.70
Coal	Neyveli Lignite Corporation Ltd	43.38	0.10
	Central Mine Planning & Design Instt.	1195.16	27.28
	Bharat Coking Coal Ltd	360.99	0.33
Power	National Thermal Power Corporation	142.00	0.20
Food	Modern Food Industries	4.13	0.09
Family Welfare	Hindustan Latex Ltd	7.81	0.39
Petrochemicals	Hindustan Organic Chemicals Ltd.	65.00	0.39

Contd..

	Indian Petrochemicals Corporation Ltd	692.00	0.71
	Petrofils Cooperative Ltd	7.20	0.05
	Indian Drugs & Pharmaceuticals Ltd	219.53	1.30
	Hindustan Antibiotics Ltd	131.53	1.78
	Hindustan Insecticides Ltd	79.37	1.45
	Smith Stainstreet Pharmaceuticals Ltd	42.00	3.50
	Bengal Immunity Ltd	26.50	3.59
Public Enterprises	Burn Standard Co.Ltd	21.97	0.16
	Bharat Ophthalmic Glass Ltd	13.65	6.04
	Cement Corporation of India Ltd	137.00	0.45
	Mining & Allied Machinery Corprn. Ltd	2.10	0.02
	National Instruments Ltd	23.67	2.47
	Tungabhadra Steel Products Ltd	0.52	0.03
	Heavy Machine Tools Plant	102.00	3.53
	Instrumentation Ltd	232.19	2.21
	National Newsprint & Paper Mills Ltd	32.50	0.54
	Bharat Heavy Plates & Vessels Ltd	22.77	0.15
	Hindustan Photo Films Mfg. Co.Ltd	105.00	0.70
	Heavy Engineering Corporation Ltd	102.00	3.53
	HMT Ltd	471.72	2.39
	Bharat Heavy Electricals Ltd	4300.00	1.65
	Bharat Pumps & Compressors Ltd	35.00	0.69
	Maruti Udyog Ltd	60.50	0.09
	Andrew Yule & Company Ltd	0.76	0.22
	Andrew Yule & Company Ltd	60.61	1.62
	Andrew Yule & Company Ltd	18.25	1.20
	Andrew Yule & Company Ltd	17.36	1.34
	Scooters India Ltd	3.28	0.30
	Hindustan Cables Ltd	135.33	0.27
	Central Metal Forming Institute	33.01	113.83
	HMT Ltd	4.35	0.27
	HMT Ltd	117.19	0.77
	HMT Ltd, Bangalore	164.67	0.88
	Hindustan Salts, Jaipur	3.80	0.83
Petroleum & Natural Gas	Lubrizol India Ltd	450.35	2.76
	Madras Refineries Ltd	222.39	0.18

Contd..

	Oil India Ltd	125.84	0.24
	Indian Oil Corporation Ltd	1471.00	0.00
	Engineers India Ltd	882.00	15.54
Steel	Bokaro Steel Plant	105.46	0.05
	Roukela Steel Plant	107.54	0.08
	IFICO	6.46	0.47
	National Mineral Development Corprn.Ltd	110.76	1.81
	MECON	32.79	0.40
	Sponge Iron India Ltd	72.00	5.54
	Durgapur Steel Plant	32.00	0.04
	Steel Authority of India Ltd	2720.81	0.51
	Visvesvaraya Iron & Steel Ltd	3.20	0.03
Mines	Bharat Gold Mines Ltd	88.40	2.44
	Mineral Exploration Corporation Ltd	2.93	0.05
	Central Research & Development Lab	99.45	0.42
	Hindustan Copper Ltd	7.03	0.08
	Bharat Aluminium Co.Ltd	62.00	0.17
Surface Transport	Hindustan Shipyard Ltd	13.13	0.15
Andhra Pradesh	Andhra Pradesh Electronics Dev.Corp.	16.00	4.42
Assam	Assam Electronics Dev.Corp.	1.39	0.95
Delhi	National Small Industries Corp.	10.00	2.50
Gujarat	Gujarat State Fertilizers Co.Ltd.	225.00	0.35
	Gujarat Communications & electronics	325.00	5.42
	Gujarat Narmada Valley Fertilizers	36.47	0.11
	Gujarat State Fertilizer Co.Ltd.	37.47	1.71
Haryana	Haryana State Electronics Dev.Corp.	85.00	60.71
Karnataka	NGEF Ltd.	86.51	0.57
	Karnataka Soaps & Detergents Ltd.	8.30	0.11
	Hutti Gold Mines Co. Ltd.	32.00	1.19
Kerala	Kerala State Drugs & Pharmaceuticals	1.95	0.48
	Titanium Products Ltd	11.10	0.26
	Kerala Minerals & Metals Ltd	28.00	0.47
Madhya Pradesh	National Information Technologies Ltd	15.23	0.33
Maharashtra	Haffkine Bio Pharmaceutical Corp. Ltd	1.45	0.16
	Maharashtra Electronics Corp. Ltd	16.50	0.41
	Maharashtra Electronics Corp.Ltd	16.00	2.67
	Maharashtra Electronics Corp.Ltd	54.85	0.00

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Orissa	Hira Cement Works	20.88	0.44
	Kalinga Iron Works	0.16	0.00
	Ferro Chrome Plant	0.50	0.04
	The Orissa State Electronics Dev.Corp.	0.04	0.57
Punjab	Punjab Tractors Ltd	51.00	0.43
	Punjab Wireless Systems Ltd	43.20	0.02
	Punjab State Hoisery & Knitware Dev.Corp.	155.00	70.45
	Bicycle & Sewing Machine R&D Centre	277.43	0.15
	Punjab Recorders	31.15	31.15
	Punjab Communications Ltd	0.70	0.05
	Punjab Power Packs	9.70	1.62
Rajasthan	Rajasthan Communications Ltd	1.20	0.56
	Rajasthan Electronics & Instruments Ltd	45.46	0.06
Tamil Nadu	Tamil Nadu Electricity Board	33.90	31.73
Uttar Pradesh	Uptron India Ltd	25.00	1.10
West Bengal	Webel Crystals Ltd	3.49	31.73
	West Bengal Electronics Industry	11.81	0.42
	Webel Business Machines Ltd	2.50	2.50
	Engel India Machines & Tools Ltd	25.00	26.32

Source: Data collected & compiled by DST.
Note :S.T.O. = Sales Turnover

Table 14
FULL TIME EQUIVALENT OF WOMEN PERSONNEL EMPLOYED IN R&D ESTABLISHMENTS BY NATURE OF WORK AS ON APRIL 1, 1988

	Establishment	R&D	Auxiliary	Administration	Total
A.	Institutional Sector				
I.	Central Government				
1.	Department of Atomic Energy	391	676	1201	2268
2.	Council of Scientific & Industrial Research	607	569	699	1875
3.	Defence Research & Development Organisation	557	330	490	1377
4.	Indian Council of * Agricultural Research	405	343	938	1686
5.	Department of Space *	106	75	239	420
6.	Indian Council of * Medical Research	134	166	117	417
7.	Other Central Govt.* Ministries/Agencies	587	1202	1552	3341
II.	State Governments	1230	453	1823	3506
B.	Industrial Sector				
1.	Public Sector including Joint Sector	592	193	301	1086
2.	Private Sector	943	226	854	2023
	Total	5552	4233	8214	17999

Source: Data collected & compiled by DST.
* 1986-87 survey figures repeated.

Table 15
CLASSIFICATION OF PERSONNEL BY TYPE OF WORK

Category of Personnel	Public sector	Private sector	Industrial sector
R&D	12652	18493	31145
Auxiliary	9747 *	10323	20070
Administration	5212 *	6499 *	11711
Total	27611	35315	62926

Source: Data collected & compiled by DST.
* Figures of 1984-85 survey repeated.

Table 16
R&D EXPENDITURE BY INDUSTRY GROUPS FOR PRIVATE SECTOR INDUSTRIES

(Rs. Lakhs)

Sl. No.	Industry Group	Number of Industries	Total R&D Expenditure			R&D Expenditure as % of S.T.O		
			1986-87	1987-88	1988-89	1986-87	1987-88	1988-89
1	Metallurgical Industries	56	1245.16	1397.28	2263.64	0.28	0.28	0.39
2	Fuels	8	153.17	101.70	168.05	0.48	0.30	0.47
3	Boilers & Steam Generating Plants	3	45.36	40.46	55.58	0.34	0.34	0.34
4	Prime Movers	3	304.44	431.52	432.29	1.15	1.22	1.60
5	Electronics & Electricals Equipment	146	4368.97	4944.23	5577.50	0.86	0.82	1.01
6	Telecommunications	32	530.33	383.88	548.32	2.05	1.74	1.37
7	Transportation	35	1858.14	2088.90	2419.25	0.62	0.63	0.69
8	Industrial Machinery	79	2189.04	2570.49	2720.72	0.31	0.31	0.25
9	Machine Tools	15	275.92	356.24	329.95	0.28	0.33	0.21
10	Agricultural Machinery	6	298.04	312.49	493.90	0.48	0.45	0.57
11	Earth Moving Machinery	1	0.67	0.82	1.70	0.14	0.14	0.25
12	Misc.Mechanical Engg.Industries	6	87.23	77.78	93.98	0.82	0.65	0.65
13	Commercial,Office,Household Equipment	6	230.47	238.01	695.61	0.52	0.42	1.03
14	Medical & Surgical Appliances	2	37.26	39.75	50.25	2.83	2.35	2.06
15	Industrial Instruments	31	1112.45	211.27	247.43	9.73	2.04	1.89
16	Scientific Instruments	11	153.95	160.04	203.35	1.09	1.06	0.86
17	Math,Surveying & Drawing Instruments	2	34.60	36.18	28.83	6.78	6.03	3.93
18	Fertilizers	2	92.51	155.81	223.60	0.22	0.40	0.48
19	Chemicals (other than fertilizers)	156	4053.22	4395.94	5336.61	0.95	0.89	0.97
20	Photographic Raw Film & Paper	2	27.92	10.94	15.30	1.61	0.56	0.68
21	Dyestuffs	10	359.50	434.39	518.44	0.76	0.92	0.93
22	Drugs & Pharmaceuticals	78	4216.21	4719.17	5177.49	1.82	1.76	1.60
23	Textiles (Dyed, Printed,Processed)	27	1216.38	1191.76	1213.64	0.33	0.24	0.35
24	Paper & Pulp	12	163.13	150.99	166.21	0.37	0.33	0.35
25	Sugar	13	334.59	439.47	418.06	0.48	0.54	0.44
26	Fermentation Industries	5	38.49	37.98	54.88	0.13	0.12	0.19
27	Food Processing Industries	20	927.89	974.99	1091.58	1.59	1.32	1.34

Contd..

28	Vegetable Oil & Vanaspati	2	13.52	18.78	19.61	0.06	0.09	0.08
29	Soaps,Cosmetics,Toilet Preparations	7	867.68	836.55	840.56	0.64	0.52	0.50
30	Rubber Goods	13	628.42	763.90	966.61	0.31	0.30	0.35
31	Leather,Leather goods & Pickers	0	0.00	0.00	0.00	0.00	0.00	0.00
32	Glue & Gelatin	3	44.15	13.83	29.66	0.24	0.06	0.11
33	Glass	4	38.61	35.15	35.28	0.55	0.54	0.45
34	Ceramics	10	267.32	281.40	376.97	1.19	1.19	1.26
35	Cement & Gypsum Products	3	525.89	572.34	596.36	0.57	0.59	0.56
36	Timber Products	2	23.03	50.74	34.00	0.34	0.67	0.42
37	Defence Industries	0	0.00	0.00	0.00	0.00	0.00	0.00
38	Miscellaneous Industries	17	216.45	228.75	210.05	0.33	0.14	0.13
	Total	828	26980.11	28703.92	33655.27	0.64	0.58	0.62

Source:Data collected & compiled by DST.

Table 17
R&D EXPENDITURE BY INDUSTRY GROUPS FOR PUBLIC SECTOR INDUSTRIES

(Rs. Lakhs)

Sl. No.	Industry Group	Number of Industries	Total R&D Expenditure			R&D Expenditure as % of S.T.O		
			1986-87	1987-88	1988-89	1986-87	1987-88	1988-89
1	Metallurgical Industries	24	3336.43	4522.59	5229.45	0.37	0.42	0.43
2	Fuels	5	1620.16	1386.18	1873.71	0.11	0.08	0.11
3	Boilers & Steam Generating Plants	1	38.03	142.20	22.77	0.40	0.96	0.15
4	Prime Movers	0	0.00	0.00	0.00	0.00	0.00	0.00
5	Electronics & Electricals Equipment	21	5116.85	5514.39	6225.01	1.63	1.54	1.55
6	Telecommunications	12	3306.72	3744.45	3717.15	1.03	1.06	0.93
7	Transportation	4	174.75	107.16	354.34	0.24	0.14	0.45
8	Industrial Machinery	7	147.85	78.26	245.32	0.81	0.43	1.01
9	Machine Tools	3	465.06	614.31	606.73	2.95	3.61	2.68
10	Agricultural Machinery	2	169.11	159.02	168.19	0.91	0.78	0.62
11	Earth Moving Machinery	0	0.00	0.00	0.00	0.00	0.00	0.00
12	Misc.Mechanical Engg.Industries	1	29.00	14.50	25.00	32.95	15.93	26.32
13	Commercial,Office,Household Equipment	0	0.00	0.00	0.00	0.00	0.00	0.00
14	Medical & Surgical Appliances	0	0.00	0.00	0.00	0.00	0.00	0.00
15	Industrial Instruments	1	169.02	155.75	232.19	2.34	1.81	2.21
16	Scientific Instruments	0	0.00	0.00	0.00	0.00	0.00	0.00
17	Math,Surveying & Drawing Instruments	1	16.62	16.15	23.67	1.78	2.09	2.47
18	Fertilizers	6	911.66	1000.35	1142.17	0.45	0.48	0.40
19	Chemicals (other than fertilizers)	6	685.56	1101.62	1327.99	0.67	0.90	0.96
20	Photographic Raw Film & Paper	1	85.55	304.91	105.00	0.72	2.22	0.70
21	Dyestuffs	0	0.00	0.00	0.00	0.00	0.00	0.00
22	Drugs & Pharmaceuticals	6	420.61	382.70	422.96	1.58	1.60	1.53
23	Textiles (Dyed, Printed, Processed)	2	58.09	76.06	162.20	0.41	0.50	1.01
24	Paper & Pulp	1	35.00	29.30	32.50	0.64	0.53	0.54
25	Sugar	0	0.00	0.00	0.00	0.00	0.00	0.00
26	Fermentation Industries	0	0.00	0.00	0.00	0.00	0.00	0.00
27	Food Processing Industries	1	3.35	2.14	4.13	0.08	0.05	0.09
28	Vegetable Oil & Vanaspati	0	0.00	0.00	0.00	0.00	0.00	0.00

Contd..

29	Soaps,Cosmetics,Toilet Preparations	1	3.87	4.25	8.30	0.09	0.10	0.11
30	Rubber Goods	1	8.14	9.42	7.81	0.72	0.50	0.39
31	Leather,leather goods & Pickers	0	0.00	0.00	0.00	0.00	0.00	0.00
32	Glue & Gelatin	0	0.00	0.00	0.00	0.00	0.00	0.00
33	Glass	1	1.62	1.64	13.65	1.76	1.62	6.04
34	Ceramics	1	2.44	4.26	6.46	0.25	0.41	0.47
35	Cement & Gypsum Products	2	60.81	98.77	157.88	0.26	0.36	0.45
36	Timber Products	0	0.00	0.00	0.00	0.00	0.00	0.00
37	Defence Industries	8	6103.62	-8391.58	12970.30	5.32	6.60	8.60
38	Miscellaneous Industries	2	599.97	984.59	1046.67	3.15	4.97	4.31
	Total	121	23569.89	28846.55	36131.56	0.64	0.69	0.78

Source:Data collected & compiled by DST.

Table 18
R&D EXPENDITURE BY INDUSTRY GROUPS FOR SMALL SCALE SECTOR INDUSTRIES

(Rs. Lakhs)

Sl. No.	Industry Group	Number of Industries	Total R&D Expenditure			R&D Expenditure as % of S.T.O		
			1986-87	1987-88	1988-89	1986-87	1987-88	1988-89
1	Metallurgical Industries	7	47.09	70.25	63.18	0.95	0.97	0.35
2	Fuels	1	20.64	12.51	14.90	0.88	0.48	0.53
3	Boilers & Steam Generating Plants	0	0.00	0.00	0.00	0.00	0.00	0.00
4	Prime Movers	0	0.00	0.00	0.00	0.00	0.00	0.00
5	Electronics & Electricals Equipment	55	380.96	403.49	636.19	1.31	1.00	1.04
6	Telecommunications	23	316.95	137.02	123.79	4.74	1.86	1.39
7	Transportation	2	2.57	6.29	4.08	0.81	1.69	0.92
8	Industrial Machinery	17	114.38	272.05	312.31	3.59	7.82	7.04
9	Machine Tools	4	13.86	25.70	36.18	7.74	9.81	10.90
10	Agricultural Machinery	1	0.02	0.04	4.66	0.29	0.44	77.67
11	Earth Moving Machinery	0	0.00	0.00	0.00	0.00	0.00	0.00
12	Misc.Mechanical Engg.Industries	2	33.79	36.14	38.38	2.50	2.50	2.52
13	Commercial,Office,Household Equipment	1	0.42	2.58	1.65	10.50	23.45	20.63
14	Medical & Surgical Appliances	1	1.77	8.23	7.68	2.21	9.35	3.34
15	Industrial Instruments	16	120.13	88.63	72.96	2.04	1.73	1.39
16	Scientific Instruments	7	29.24	23.98	32.90	5.33	3.40	3.89
17	Math,Surveying & Drawing Instruments	0	0.00	0.00	0.00	0.00	0.00	0.00
18	Fertilizers	0	0.00	0.00	0.00	0.00	0.00	0.00
19	Chemicals (other than fertilizers)	46	131.89	189.69	220.50	0.99	1.38	1.47
20	Photographic Raw Film & Paper	0	0.00	0.00	0.00	0.00	0.00	0.00
21	Dyestuffs	0	0.00	0.00	0.00	0.00	0.00	0.00
22	Drugs & Pharmaceuticals	18	131.30	161.22	148.32	1.16	1.22	0.88
23	Textiles (Dyed, Printed, Processed)	1	1.78	2.31	2.54	1.91	2.20	1.95
24	Paper & Pulp	0	0.00	0.00	0.00	0.00	0.00	0.00
25	Sugar	0	0.00	0.00	0.00	0.00	0.00	0.00
26	Fermentation Industries	0	0.00	0.00	0.00	0.00	0.00	0.00
27	Food Processing Industries	8	175.55	219.76	241.38	8.76	9.98	8.48
28	Vegetable Oil & Vanaspati	0	0.00	0.00	0.00	0.00	0.00	0.00
29	Soaps,Cosmetics,Toilet Preparations	0	0.00	0.00	0.00	0.00	0.00	0.00

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30	Rubber Goods	1	1.05	3.21	7.29	0.91	2.33	4.67
31	Leather,Leather goods & Pickers	0	0.00	0.00	0.00	0.00	0.00	0.00
32	Glue & Gelatin	0	0.00	0.00	0.00	0.00	0.00	0.00
33	Glass	0	0.00	0.00	0.00	0.00	0.00	0.00
34	Ceramics	0	0.00	0.00	0.00	0.00	0.00	0.00
35	Cement & Gypsum Products	0	0.00	0.00	0.00	0.00	0.00	0.00
36	Timber Products	0	0.00	0.00	0.00	0.00	0.00	0.00
37	Defence Industries	0	0.00	0.00	0.00	0.00	0.00	0.00
38	Miscellaneous Industries	4	34.99	48.03	26.04	2.62	3.90	1.62
	Total	215	1558.38	1711.13	1994.93	1.88	1.71	1.42

Source:Data collected & compiled by DST.

Table 19

DISPERSAL OF PRIVATE SECTOR INDUSTRIAL R&D UNITS IN VARIOUS STATES & UNION TERRITORIES AND THEIR R&D EXPENDITURE FROM 1986-87 TO 1988-89

(Rs. Lakhs)

Sl. No.	Name of State	Number of Industries	R&D Expenditure		
			1986-87	1987-88	1988-89
1	Andaman & Nicobar Island	0	0.00	0.00	0.00
2	Andhra Pradesh	46	949.72	1104.58	1332.98
3	Arunachal Pradesh	0	0.00	0.00	0.00
4	Assam	2	10.31	6.44	6.25
5	Bihar	11	676.75	770.51	1567.94
6	Chandigarh	15	135.65	179.14	193.87
7	Delhi	30	803.84	840.46	1319.14
8	Dadra & Nagar Haveli	2	15.57	20.95	26.26
9	Daman & Diu	0	0.00	0.00	0.00
10.	Goa	1	10.24	4.60	4.83
11	Gujarat	69	2074.66	1931.53	2173 67
12	Haryana	24	334.66	372.92	442.69
13	Himachal Pradesh	0	0.00	0 00	0.00
14	Jammu & Kashmir	0	0.00	0.00	0.00
15	Karnataka	66	1632.51	1989.95	2074.34
16	Kerala	11	347.84	546.49	617.29
17	Lakshdweep	0	0.00	0.00	0.00
18	Madhya Pradesh	24	441.43	550.28	491.10
19	Maharashtra	308	11980.66	13646.39	15555.85
20	Manipur	0	0.00	0.00	0.00
21	Meghalaya	0	0.00	0 00	0.00
22	Mizoram	1	384.53	475.00	450.00
23	Nagaland	0	0.00	0.00	0.00
24	Orissa	5	140.38	160.44	191.56
25	Pondicherry	1	0.01	0.09	0.17
26	Punjab	15	353.21	359.10	338.20
27	Rajasthan	11	672.61	443.20	545.81
28	Sikkim	0	0.00	0.00	0.00
29	Tamil Nadu	87	1974.54	2070.75	2673.43
30	Tripura	0	0.00	0 00	0.00
31	Uttar Pradesh	39	1382.08	498.01	645.42
32	West Bengal	60	2658.91	2733.09	3004.46
	Total	828	26980.11	28703.92	33655.26

Source: Data collected & compiled by DST.

Table 20

DISPERSAL OF PUBLIC SECTOR INDUSTRIAL R&D UNITS IN VARIOUS STATES & UNION TERRITORIES AND THEIR R&D EXPENDITURE FROM 1986-87 TO 1988-89

(Rs.Lakhs)

Sl. No.	Name of State	Number of Industries	R&D Expenditure		
			1986-87	1987-88	1988-89
1.	Aandaman & Nicobar Island	1	6.52	4.34	3.49
2.	Andhra Pradesh	13	5448.71	5565.05	5962.62
3.	Arunachal Pradesh	0	0.00	0.00	0.00
4.	Assam	2	276.62	151.85	127.23
5.	Bihar	10	3534.03	4520.94	5223.21
6.	Chandigarh	0	0.00	0.00	0.00
7.	Delhi	6	560.84	1012.08	1101.44
8.	Dadra & Nagar Haveli	0	0.00	0.00	0.00
9.	Daman & Diu	0	0 00	0.00	0.00
10	Goa	0	0.00	0.00	0.00
11..	Gujarat	6	802.41	1189.85	1323.14
12.	Haryana	4	1242.44	1377.07	1752.56
13.	Himachal Pradesh	0	0.00	0.00	0.00
14.	Jammu & Kashmir	0	0.00	0.00	0.00
15.	Karnataka	15	8609.67	11541.52	16222.76
16.	Kerala	6	113.30	117.15	238.21
17.	Lakshadweep	0	0.00	0.00	0.00
18.	Madhya Pradesh	4	166.71	211.08	246.73
19.	Maharashtra	11	737.16	820.39	1116.98
20.	Manipur	0	0.00	0.00	0.00
21.	Meghalaya	0	0.00	0.00	0.00
22.	Mizoram	0	0.00	0.00	0.00
23.	Nagaland	0	0.00	0.00	0.00
24.	Orissa	5	118.93	137.28	129.12
25.	Pondicherry	0	0.00	0.00	0.00
26.	Punjab	7	194.65	217.47	568.18
27.	Rajasthan	5	270.15	306.78	382.10
28.	Sikkim	0	0.00	0.00	0.00
29.	Tamil Nadu	6	474.27	566.25	478.11
30.	Tripura	0	0.00	0.00	0.00
31.	Uttar Pradesh	6	838.02	928.20	957.49
32.	West Bengal	14	175.46	179.25	298.18
	Total	121	23569.89	28846.55	36131.55

Source: Data collected & compiled by DST.

Table 21

DISPERSAL OF SMALL SCALE INDUSTRIAL R&D UNITS IN VARIOUS STATES & UNION TERRITORIES AND THEIR R&D EXPENDITURE FROM 1986-87 TO 1988-89

(Rs. Lakhs)

Sl. No.	Name of State	Number of Industries	R&D Expenditure 1986-87	1987-88	1988-89
1	Andaman & Nicobar Island	0	0.00	0.00	0.00
2	Andhra Pradesh	16	109.36	304.66	303.35
3	Arunachal Pradesh	0	0.00	0.00	0.00
4	Assam	0	0.00	0.00	0.00
5	Bihar	1	31.88	49.50	42.44
6	Chandigarh	8	42.72	52.23	61.64
7	Delhi	13	95.57	112.56	142.54
8	Dadra & Nagar Haveli	1	0.55	0.21	0.26
9.	Daman & Diu	0.	0.00	0.00	0.00
10	Goa	1	10.24	4.60	4.83
11	Gujarat	18	167.20	136.79	164.08
12	Haryana	4	15.51	17.43	18.27
13	Himachal Pradesh	0	0.00	0.00	0.00
14	Jammu & Kashmir	0	0.00	0.00	0.00
15	Karnataka	25	88.92	109.28	138.65
16	Kerala	1	3.16	4.30	4.51
17	Lakshdweep	0	0.00	0.00	0.00
18	Madhya Pradesh	5	17.65	24.31	26.86
19	Maharashtra	75	586.29	679.78	816.65
20	Manipur	0	0.00	0.00	0.00
21	Meghalaya	0	0.00	0.00	0.00
22	Mizoram	0	0.00	0.00	0.00
23	Nagaland	0	0.00	0.00	0.00
24	Orissa	1	7.66	3.45	4.85
25	Pondicherry	1	0.01	0.09	0.17
26	Punjab	0	0.00	0.00	0.00
27	Rajasthan	3	4.84	5.21	9.64
28	Sikkim	0	0.00	0.00	0.00
29	Tamil Nadu	21	313.07	139.11	154.37
30	Tripura	0	0.00	0.00	0.00
31	Uttar Pradesh	9	22.55	18.21	23.63
32	West Bengal	12	41.20	49.41	78.19
	Total	215	1558.38	1711.13	1994.93

Source: Data collected & compiled by DST.

Table 22
MINISTRY-WISE R&D EXPENDITURE FOR PUBLIC SECTOR INDUSTRIES

(Rs.Lakhs)

Sl. No.	Name of Ministry/ Department	Number of Industries	Total R&D Expenditure			R&D Expenditure as % of S.T.O		
			1986-87	1987-88	1988-89	1986-87	1987-88	1988-89
1.	Agriculture & Cooperation	0	0.00	0.00	0.00	0.00	0.00	0.00
2.	Agricultural Research & Education	0	0.00	0.00	0.00	0.00	0.00	0.00
3.	Rural Development	0	0.00	0.00	0.00	0.00	0.00	0.00
4.	Fertilisers	4	693.97	735.61	880.70	0.53	0.50	0.46
5.	Commerce	0	0.00	0.00	0.00	0.00	0.00	0.00
6.	Textiles	0	0.00	0.00	0.00	0.00	0.00	0.00
7.	Supply	0	0.00	0.00	0.00	0.00	0.00	0.00
8.	Posts	0	0.00	0.00	0.00	0.00	0.00	0.00
9.	Telecommunications	4	2730.66	3236.68	3135.03	4.96	5.24	3.63
10.	Defence	0	0.00	0.00	0.00	0.00	0.00	0.00
11.	Defence Production & Supplies	8	6103.62	8391.58	12970.30	5.32	6.60	8.60
12.	Coal	3	373.06	1326.40	1599.53	0.31	0.92	1.04
13.	Power	1	54.40	71.00	142.00	0.08	0.10	0.20
14.	Food	1	3.35	2.14	4.13	0.08	0.05	0.09
15.	Civil Supplies	0	0.00	0.00	0.00	0.00	0.00	0.00
16.	Health	0	0.00	0.00	0.00	0.00	0.00	0.00
17.	Family Welfare	1	8.14	9.42	7.81	0.72	0.50	0.39
18.	Home	0	0.00	0.00	0.00	0.00	0.00	0.00
19.	Education	0	0.00	0.00	0.00	0.00	0.00	0.00
20.	Culture	0	0.00	0.00	0.00	0.00	0.00	0.00
21.	Industrial Development	0	0.00	0.00	0.00	0.00	0.00	0.00
22.	Petrochemicals	8	926.36	1177.89	1263.13	0.73	0.82	0.78
23.	Public Enterprises	28	5954.23	6046.95	6221.20	1.38	1.24	1.09
24.	Information & Broadcasting	0	0.00	0.00	0.00	0.00	0.00	0.00
25.	Labour	0	0.00	0.00	0.00	0.00	0.00	0.00
26.	Petroleum & Natural Gas	5	2138.53	2468.11	3151.58	0.15	0.15	0.18
27.	Statistics	0	0.00	0.00	0.00	0.00	0.00	0.00

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28.	Steel	8	2714.26	2970.74	3187.82	0.37	0.34	0.32
29.	Mines	5	189.80	211.15	259.81	0.31	0.30	0.34
30.	Railways	0	0.00	0.00	0.00	0.00	0.00	0.00
31.	Civil Aviation	0	0.00	0.00	0.00	0.00	0.00	0.00
32.	Surface Transport	1	0.78	11.94	13.13	0.01	0.15	0.15
33.	Urban Development	0	0.00	0.00	0.00	0.00	0.00	0.00
34.	Water Resources	0	0.00	0.00	0.00	0.00	0.00	0.00
35.	Department of Atomic Energy	3	363.08	406.93	723.97	1.88	1.77	2.62
36.	Department of Electronics	2	223.76	283.06	441.87	1.32	1.46	2.13
37.	Department of Scientific & Industrial Research	1	91.75	300.00	380.00	6.22	14.79	15.14
	Total	83	22569.75	27649.60	34382.01	0.67	0.72	0.81

Source:Data collected & compiled by DST.

Table 23
EDUCATIONAL QUALIFICATIONS OF R&D PERSONNEL EMPLOYED IN INDUSTRIAL SECTOR AS ON 1.4.1988

Qualification & Discipline Sectors	Public Sector	Private Sector	Industrial Sector
I. Ph.D			
Natural Sciences	397	897	1294
Agricultural Sciences	15	58	73
Engineering/Technology	262	350	612
Medical Sciences	6	60	66
Social Sciences	0	3	3
Total I	680	1368	2048
II. Post Graduates			
Natural Sciences	536	1995	2531
Agricultural Sciences	9	113	122
Engineering/Technology	1532	1705	3237
Medical Sciences	5	132	137
Social Sciences	7	20	27
Total II	2089	3965	6054
III. Graduates			
Natural Sciences	620	2465	3085
Agricultural Sciences	7	125	132
Engineering/Technology	3563	4341	7904
Medical Sciences	3	124	127
Social Sciences	37	118	155
Total III	4230	7173	11403
IV. Diploma & Others			
Natural Sciences	482	972	1454
Agricultural Sciences	3	69	72
Engineering/Technology	5068	4610	9678
Medical Sciences	0	71	71
Social Sciences	45	63	108
Total IV	5598	5785	11383
Total (I+II+III+IV)	12597	18291	30888

Source: Data collected & compiled by DST.

Table 24
SALARY STRUCTURE OF R&D PERSONNEL EMPLOYED IN PUBLIC SECTOR AS ON 1.4.1988

Salary Scale	No. of personnel in position
Less than Rs.1000	1482 (12.5)
Rs.1000 to Rs.2000	5898 (49.6)
Rs.2000 to Rs.3000	2974 (24.9)
Rs.3000 to Rs.4000	848 (7.1)
Rs.4000 to Rs.5000	487 (4.1)
Rs.5000 to Rs.6000	165 (1.4)
Rs.6000 to Rs.7000	40 (0.3)
Rs.7000 to Rs.8000	7 (0.06)
More than Rs.8000	1 (0.01)
Total	11902 (100.0)

Source : Data collected & compiled by DST.

Note : 1) Figures in bracket indicate the percentages.
2) Based on response received.

Table 25
SALARY STRUCTURE OF R&D PERSONNEL EMPLOYED IN PRIVATE SECTOR AS ON 1.4.1988

Salary Scale	No. of personnel in position
Less than Rs.1000	1174 (6.8)
Rs.1000 to Rs.2000	4241 (24.7)
Rs.2000 to Rs.3000	4311 (25.1)
Rs.3000 to Rs.4000	3323 (19.4)
Rs.4000 to Rs.5000	2065 (12.0)
Rs.5000 to Rs.6000	1065 (6.2)
Rs.6000 to Rs.7000	536 (3.1)
Rs.7000 to Rs.8000	214 (1.2)
More than Rs.8000	247 (1.5)
Total	17176 (100.0)

Source : Data collected & compiled by DST.

Note : 1) Figures in bracket indicate the percentages.
2) Based on response received.